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DYNAMICS OF TREE-CROP INTERFACE IN RELATION TO THEIR INFLUENCE ON MICROCLIMATIC CHANGES—A REVIEW

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ABSTRACT: Integration of trees with crops adds a significant element of biological diversity to agronomic systems and promotes sustainable, protective and productive land use. The biological interactions between the major components i.e., trees and crops are of primary importance and introduce challenges and complexities not present in sole cropping. Specifically, it must be demonstrated that satisfactory growth and yields of both trees and crops can be achieved in the microenvironment of the agroforestry land-use system that varies considerably with time. Compared to an open environment, the modified microclimate under trees will have reduced solar radiation, a lowered red: far-red light ratio, a more moderate temperature regime, higher humidity, lower rates of evapo-transpiration and higher soil moisture levels. All of these factors will change as a function of tree development and tree management practices. The spacing arrangement chosen for trees will also be a factor in determining how rapidly the changes come into play. During the establishment phase, tree shade will be minimal and have little significant effect on the understory companion crops. However, as the trees grow, the changes in the microclimate will become more pronounced, which might strongly affect the growth and compatibility of the understory companion crop.

Keywords : *Agroforestry, microclimate, solar radiation, energy balance.*

Agroforestry system is a complex and living system which integrates the trees and results in changes in the microclimate which in turn influence the growth of all components of the system. Agroforestry techniques were designed with the aim of increasing soil fertility, there is now growing evidence of improved soil nutrients, microclimatic condition and increased crop production beneath large isolated trees due to efficient recycling of nutrients. If we try to understand and predict the results of combining tree and crops under different circumstances, it is important to know the functioning that control these changes and to appropriate their potential effects on plant growth and development. To explain why particular agroforestry system work in one environment and not in another, and how to manage them, requires a better understanding in order to cover the large number of possible plant combinations and their adaptability in wide range of climate and the development of appropriate management practices. A large number of changes occur when a tree is introduced into a field. The combined effect of these changes control the energy balances of both the overstorey and the understorey, thus influencing plant water use and productivity. Temporal and spatial complimentarity of resource capture by tree and crops in a agroforestry system is a major determinant of the ability of the system to improve crop yields and overall productivity (Cannell *et al.,* 7; Ong and Black, 36). Agroforestry research has largely concentrated on understanding above-ground interaction, such as light interception and microclimate modification (Corlet *et al.,* 9). To understand the main microclimatic effects that occur in tree-crop interface (agroforestry) this paper explains the specific microclimatic changes by radiation, wind, air, humidity and temperature and their effect on evaporation of water and growth in the context of agroforestry practices.

1. Solar radiation dynamics and their influence on microclimate:

In all agroforestry systems the planting of trees changes the average radiation incident on

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understorey plants. These changes are often considered a disadvantage although some authors have found that they are advantageous (Vandenbeldt and Williams, 38). Under clear sky conditions negative balance of solar radiation causing night time cooling of the atmosphere, this is because the sky is cooler than the soil or vegetation, however under a tree canopy downward long wave radiation fluxes would be similar to upward long wave fluxes from crops, thus rates of cooling of understoreys are considerably slower. This proves that less frost is observed under trees or in forests than in open fields, and may be an important function of 'shade tree' in coffee and tea plantations where these are susceptible to frost or chilling damage. When plant growth is not limited by water or nutrients, production is limited by the amount of radiant energy that foliage can intercept (Monteith *et al.,* 22; Monteith, 23).

Various studies have examined the mechanism of competition for light between trees and annual crops (Monteith *et al.* 22; Knowles *et al.,* 18; Gillespie *et al.,* 13). Biomass growth is dependent upon the fraction of incident photosynthetically active radiation (PAR, 400 to 700 mm wave length) that each species intercepts and the efficiency with which the intercepted radiation is converted by photosynthesis (Ong *et al.,* 26). These factors, in turn influenced by time of day aspect, temperature, CO_2 level, species combination, photosynthetic pathway (C_3 vs C_4), canopy structure, plant age and height, leaf area and angle and transmission and reflectance traits of the canopy (Brenner and Jarvis, 5; Kozlowski and Pallardy, 19). Shading by associated tree species has been shown to be a factor in reducing yield in temperate agroforestry systems. Low PAR levels resulting from overhead shading significantly reduced yield of winter wheat near tree row in a paulownia-winter wheat temperate cropping system in China (Chirko *et al.,* 8). Nissen *et al.* (25) also reported that both shading and belowground competition decreased the yield of cabbage (*Brassica oleracea*) in a eucalyptus based alley cropping system in the Phillippines. Maize and soybean yields were reduced to 75% of the sole crop yield, respectively, when grown in alley cropping configurations involving popular (*Populus deltoids*).

Some studies have investigated the physiological basis of observed yield reduction in response to shading in agroforestry systems (Jose *et al.,* 17). Shading is known to change quality of light reaching the understorey canopy; overhead canopies absorb mostly the red and blue portion of the solar spectrum so that diffuse radiation will be richer in orange, yellow and green wavelengths to influence the amount of growth regulating amount harmones and thereby growth (Baraldi *et al.,* 4). Lack of adequate red light is known to influence tillering in grasses (Davis and Simmons, 10), stem production in clover (*Trifolium spp.*) (Robin *et al.,* 33), flowering (Davis and Simmons, 11) and other basic plant growth processes (Sharrow, 36). Contrary to an expected yield decrease in maize (a C_4 species) in response to shading, Gillespie *et al.,* (13) reported no effect in two alley cropping systems in Midwestern United States. The researchers found that, irrespective of shading, no apparent yield reduction was observed when belowground competition for nutrient and water was eliminated through trenching and polyethylene barriers. Leihner *et al.,* (20) also reported similar finding in maize and concluded that shading played only a minor role in competition at the tree crop interface.

Positive effects of moderate shading on crop growth have been reported in some cases. Lin *et al.,* (21) found that two native warm season legumes, *Desmodium canescens* and *D. poniculatum,* exhibited shade tolerance and had significantly higher dry weight at 50% and 80% shade than in full sunlight. Burner and Brauer (1) reported that orchard grass (*Dactylis glomerata*) yield across six harvests did not differ among loblolly pine (*Pinus toeda*) and short leaf pine (*Pinus echinata*) silvopastures compared to yield in open pastures. In another study of a loblolly Pine-mixed grass/forb silvopasture, Burner and Brauer (6) showed that herbage yield was unaffected at alley

widths of 4.9 m and above. Light transmittance was as high as 90 % at this spacing. Alley widths below 4.9 m had a profound influence on light transmittance.

2. Solar radiation and their influence on energy balance:

Changes in wind speed and radiation caused by introducing tree have very important effects on the energy balance of the plant. Plant must lose the same amount of energy they absorb if they are to remain at a constant temperature. Although a certain amount of energy is stored as chemical bond energy, photosynthesis and physical storage of heat, energy is lost mainly by evaporation and convection (Jones, 16). Nearly all land plants have stomata, some species have stomata on both sides (amphistomatous) and others have stomata on the lower side only (hypostomatous). The main environmental variables to which stomata respond are to photosynthetic quantum flux density, vapour pressure deficit, leaf water status, leaf temperature and internal CO_2 concentration.

Table 1: Stomatal (gs), canopy (gc) and boundary layer (ga) conductances for a variety of vegetative surfaces.

Vegetation type	Stomatal conduc-tance (mm s^{-1}) on a leaf area basis	Canopy conduc-tance (mm s^{-1}) on ground area basis	Boundary layer conduc-tance (mm s^{-1}) on ground area basis
Grassland	10	20	5-20
Agricultural crops	20	50	20-50
Plantation forest	6	20	100-330

(**Source:** Jarvis, 15).

Shading by overstorey causing changes in stomatal conductance. Competition for water between overstorey and understorey changes leaf water status and shelter changes microclimate. So plants growing under tree may have different conductances from those grown in monoculture, changing their evaporation and photosynthetic rates. Conductance of a canopy is generally taken as average stomatal conductance multiplied by plant leaf area index. Many developmental processes are temperature controlled with their rate increasing linearly above a base temperature (Jones, 16). The rate of germination of millet seed, for example, increase linearly with soil temperature from 10-12°C to an optimum temperature of 32-33 °C, then decreases linearly to a lethal temperature at around 48°C. It has been suggested that one of the major causes of improved crop growth under a canopy of *Faidherbia albida* is reduction of soil temperatures at the beginning of the season, as a result of shading of the soil by the tree canopy since in the semi-arid tropics soil temperatures can exceed 50°C (Vandenbeldt and Williams, 38). Soil temperature particularly affects germination and early growth of cereals since the meristem remains below ground level for the first 3 weeks of plant development (Ong, 28; Corlett *et al.,* 9). Optimum temperatures for growth processes depend upon the species and process. For example, leaf extension in millet was found to correspond well to meristem temperatures, with the rate expansion decreasing above 32°C (Ong, 29; Terry *et al.,* 37). However, optimum temperatures for grain yields and tillering were lower, between 20°C and 27°C (Russell *et al.*, 34). Temperature also affects the duration of the growth stages, so that advantages of faster rates of increase may be offset by shorter duration of that advantages of faster rates of increase may be offset by shorter duration of that growth stage (Ong and Monteith, 27).

3. Influence of temperature and humidity on microclimatic changes

The effect of trees on soil and air temperature is an important parameter for the agroforestry system, since the photosynthesis-respiration relationship, which depends largely on ambient temperature, playes a vital role in the accumulation of carbohydrate and in the control of the survival of crops in those systems (Sanchez, 35). Lower temperature beneath tree crowns may reduce water stress and increase biomass of below-crown species (Amundson *et al.,* 1), if competition for light or soil moisture does not overcome the benefits of reduced temperature to the species beneath the tree crown. In an study it was found that soil and air

temperature were, on an average 15.6 and 2.8°C cooler under the crown of *Z. joazeiro* trees, respectively, when compared to patches of *C. ciliaris*. In contrast, the presence of *P. juliflora* trees had no significant effect on soil temperatures and contributed to a decrease of only 1.4°C in below crown air temperatures. Similarly, previous studies have shown that soil temperature were 5 to 12°C lower under the crowns of *Acacia tortilis* and *Adansonia digtata* trees in Kenyan savannas (Rhoades, 32). It is reported that air temperatures beneath tree crowns in a seven-year old *A. tortilis* plantation during a monsoon season were 0.1 to 2°C lower than temperature recorded in the open. The different effect of *Z. joazeiro* and *P. juliflora* on soil and air temperatures is different in crown structure between these two tree species. The crown of *P. juliflora* intercepted only 20 to 30 % of the total solar radiation during the same period.

Temperature reductions can help reduce heat stress of crops and/or animal in agroforestry systems. Crops such as cotton (*Gossypium hirsutum*) and soyabean (*Glycine max*) have been observed to have higher rates of field emergence when at moderate temperatures. Ramsey and Jose (31) in their study of a pecan (*Carya illinoesis*) cotton alley cropping system in the southern United States, observed earlier germination and higher survival rates of cotton under pecan canopy cover due to cooler and moisture soil conditions than in also system. A study in Nebraska, Midwestern United States, showed earlier germination, accelerated growth and increased yields of tomato (*Lycopersicon esculentum*) and snap bean (*Phaseolus vulgaris*) under simulated narrow alleys compared to wider alleys (Bagley, 2; Garrett and McGraw, 12). Studies on paulownia-wheat (*Triticum aestivum*) intercropping in temperate China have shown increased wheat quality due to enhanced microclimate conditions (Wang and Shogren, 39).

4. Wind dynamic and their influence on micro-climate:

The changes the wind pattern in a field both by altering the horizontal wind speed and turbulence; thus absorb momentum and force the air to flow around them. The velocity of the air flow increases with distance from an object that absorbs momentum, whether leaf or agroforest, and if the extent of the surface is sufficient, an air-flow profile develops that is characteristic of that surface. This characteristic profile defines the boundary layer, and affects the fluxes of energy and mass to and from the surface. A relatively simple level from which to start to scale up boundary layers for agroforests is a leaf. Boundary layer conductance at the agroforest scale depends on surface roughness (widely spaced trees are aerodynamically rougher than pastures), extant of surface and speed and turbulence of incident air flow. A characteristic boundary layer might develop above an extensive and uniform agroforestry system at around 1 m of characteristic boundary layer for each 200 m of system (Monteith *et al.,* 24), but many agroforestry systems are small in extent, thus its boundary layer would be constantly in transition between the agroforest and the surrounding vegetation.

Shelter within agroforestry system may limit mechanical damage or improve quality in other ways. Such improvements with shelter have been noted in various crops, *e.g.* more palatable pasture, less fibrous oats with higher protein content, higher sugar content in sugar beet, larger and finer tobacco leaves, non-spoiled asparagus, higher sugar level in citrus, improve flower set in avocados, and higher exportable crop in kiwi fruit (Baldwin, 3). Jaffe (14) showed mechanical rubbing of leaves inhibited wheat growth by 11%, considerably less than more sensitive crops such as maize (28%) and beans (45%).

In nutshell it can be concluded that major interactions between tree and crop demands, better understanding of the behavior and management of agroforestry system, for example, the effect of solar radiation due to increased leaf area of an upper canopy in an agroforestry system, reduces the energy available for photosynthesis and consequently also reduces the temperatures of soil

and optimum for a specific plant growth process. It also reduce the risk of frost because of the increase in the downward flux of long wave radiation relative to an open sky, and reduces energy available for evaporation from soil and crop. The relative importance of these processes in terms of productivity varies between different environment and agroforestry systems.

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SEED GERMINATION OF FRUIT CROPS : A REVIEW

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ABSTRACT: Seed germination is the resumption of active growth of embryo that results in the emergence of the young plant. Seeds of many fruit crops remain ungerminated even under favourable conditions. Such kind of dormancy in seeds may be due to presence of hard and impermeable seed coat, germination inhibitors or due to improper development of embryo. Such seeds may require special treatments like scarification, soaking in water, growth regulators etc. for overcoming dormancy. This review summarises the latest developments in seed germination in different fruits cops.

Keywords: *Seed, dormancy, seed germination, scarification, growth regulators.*

In recent years asexual methods of propagation such as wedge grafting, inarching, veneer grafting, forkert, patch, shield budding and layering have been found to be quite successful and their use has been advocated. However, even for grafting and budding seedlings have to be raised. Seedling trees bear fruits of variable size and quality but such trees are generally long-lived. For raising rootstocks, seeds are used to obtain seedlings on which the desired variety (scion) can be grafted. Most of the fruit crop seeds germinate poorly and unevenly and require more time for seedling emergence. The dormancy in seeds might be due to hard seed coat, impermeability to water and gases, physiological immaturity of embryo, deficiency of some endogenous growth promoters or excess of endogenous growth inhibitors. Different methods like water soaking, scarification and chemical treatments are used for breaking dormancy in such seeds to improve germination. Soaking of seeds in water promotes germination by softening the hard seed coat, activating the enzymes and diluting the effects of inhibitors. Duration of soaking varies from overnight to 3 or 4 days depending on the nature of seed coat while, scarification is the process of injuring the hard seed coat by any means to accelerate the water absorption and to improve the gaseous exchange for hastening the process of germination. This can be achieved by mechanical scarification or by acid scarification. In mechanical scarification, the surface of the seed is scratched or injured by rubbing against rough surface or sand paper. The extent of the scarification depends on the species. In acid scarification the seeds are dipped in concentrated acid for varying duration depending on the hardness of the seed coat. Seeds are then washed thoroughly in water to remove the traces of acid. In other instances, seeds can be pre-treated with some chemicals like gibberellic acid, thiourea and potassium nitrate to improve seed germination. Seeds are soaked in the aqueous solution of these chemicals for 12 to 48 hours before sowing. These chemicals are reported to have strong influence on the seedling growth after germination.

Effect of Water Soaking

Water participates in many biochemical reactions and serves as a medium for the life processes. In seeds, water is an essential factor in the external environment for the stimulation of germination. Soaking the seeds in water at room temperature helps in softening the seed coats, removal of inhibitors and reduces the time required for germination and increases germination percentage (Hartman and Kester, 10). Effect of different water and acid soaking periods on seed germination were studied in guava cv. Allahabad Safeda. Seeds soaked in water for 36 hours exhibited an increased percentage germination (90%) and a reduced time for seedling emergence

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in comparison to seeds soaked in H_2SO_4, HCl and HNO_3 (Pandey and Singh, 23). The percentage germination was highest (90%) and the rate of germination was fastest in seeds soaked in water for 4 days followed by 24 hours in 1000 ppm GA_3. Ergostim (5% folcysteine + 0.1% folic acid) treatment had no effect on seed germination of guava (Rodriguez *et al.,* 30). The germination of guava seed was improved by soaking it in tap water before sowing. Cold water also had a beneficial effect but soaking in hot water was harmful (Haq *et al.,* 11). The extracted seeds of ber soaked for 24 hours in water promoted early germination, good vegetative growth and higher germination percentage compared with sowing whole seeds (control). Cracked seeds exhibited better germination than control seeds but were not good as water soaked seeds (Mankar *et al.,* 18).

Soaking of jackfruit seeds in water for 24 hours has been found to improve the germination (Singh, 33). The effects of soaking seeds in water, ferulic acid (10-3 M), maleic hydrazide (1000 ppm), thiourea (1%), KH_2PO_4 (1%), or gibberellic acid (100 ppm) for 24 h before sowing on jackfruit seed germination and seedling growth were studied. The highest germination percentage (98.0%) and coefficient of germination velocity (28.00) were obtained with seed soaking in gibberellic acid. The lowest number of days required for maximum germination (10.66 days) and the highest germination value (24.38) and stem diameter (2.36 cm) were obtained with soaking of seeds in water. The tallest plants (25.10 cm) were recorded for the control followed by seed soaking in gibberellic acid (24.90 cm) (Maiti *et al.,* 17). Bael seeds were treated with different chemicals: concentrated H_2SO_4 for 10 or 20 minutes, H_2SO_4 for 10 minutes + 1% thiourea, 100 ppm GA_3, H_2SO_4 for 10 minutes + 100 ppm GA_3, 0.5% or 1% thiourea, soaking in water for 24 hours and mechanical scarification by sand paper. Among the various treatments, water soaking resulted in the highest percentage germination (80%) which was closely followed by concentrated H_2SO_4 treatment for 20 minutes (76%). It was least with concentrated H_2SO_4 for 10 minutes + 1% thiourea (20%). Although water soaking resulted in the highest percentage of ultimate germination, initiation and completion of germination took longer than treatment with concentrated H_2SO_4 (Nayak and Sen, 20). Investigations on the effect of organic and inorganic substances on germination of jamun (*Syzygium cumini*) seeds revealed that such treatments had a significant effect on germination percentage, shoot length and root length. The highest germination percentages were recorded when seeds were treated with water for 48 h, GA_3 at 250 ppm, hot water, cow dung for 24 hours and cow urine for 24 h (96.6%). The lowest percentage germination (56.6%) was recorded in the control. Shoot length was longest in the cow urine. Root length was longest in the GA_3 at 250 ppm treatment (Swamy *et al.,* 40). The effects of soaking mango (var. Local, Neelum and Totapuri) seeds in tap water for 24 h, hot water at 60°C for 5 minutes, gibberellic acid (GA_3) at 100 or 150 ppm for 24 h, water for 24 h followed by GA_3 (100 or 150 ppm) or treatment with thiourea at 150 ppm for 24 hours on germination was determined. Treatment with thiourea (1500 ppm) and soaking for 24 h in water followed by soaking for 12 or 24 h in 150 ppm GA_3 resulted in the highest germination percentage (Pillewan *et al.*, 26).

Effect of Mechanical Scarification

After 30 days from extraction, germination was highest (84%) in ber seeds scarified mechanically, however, after 203 days; it was highest (88%) in seed treated with 1% potassium hydroxide (Ghosh and Sen, 9). Seeds of the ber cultivar Umran were (a) scarified with H_2SO_4 for 6 minutes, (b) cracked manually, (c) the kernels were extracted by breaking the endocarp, and (d) left untreated (control). The treated and control seeds were either sown directly or after soaking in water for 24 h. The shortest time taken to start germination (7 days), the highest final germination percentage (46.66%) and the best seedling growth were obtained when the kernels were extracted by breaking endocarp + water soaking. The

corresponding control figures were 24.5 days and 17.5 % germination (Murthy and Reddy, 19). Breaking of hard shell in Ber helps in early germination (Singh, 34). The maximum germination in jackfruit seeds was obtained when outer thin leathery seed coat was removed and soaked in water for 8 hours. Treatment with of seeds with biotin (10 ppm) and kinetin (50 ppm) resulted in significantly higher seed vigour index. Seedling growth was also better when seeds were soaked in 25 ppm NAA (Prakash, 27).

A field experiment was conducted to find out the effect of cracking and seed coat removal on germination of mango seed. Intact seeds took 23.71 and 55.21 days for the start of germination and to attain 50% of final germination, respectively and the final germination percentage was 45.71. When the seed coat and testa were removed before sowing, the seeds started germinating on the 10th day and reached 50% of final germination in 29.46 days. The final germination was 78.57% (Padma and Reddy, 21). This experiment was conducted to study the effect of seed husking and soaking in GA_3 on germination and vegetative growth parameters of Zebda, Sukkary, Sabre and 13-1 polyembryonic mango rootstocks under nursery conditions. Germination percentage and number of seedlings per seed increased with seed husking and soaking in GA_3 at 100 or 200 ppm concentrations for 48 hours. The highest germination percentage and number of seedlings were recorded by Sabre rootstock meanwhile, the lowest was recorded by Sukkary rootstock. Seedling length, seedling diameter, number of leaves per seedling, leaf area and root length of the studied rootstocks were increased with seed husking and GA_3 treatments. The highest values of seedling length, diameter, leaf area and number of leaves per seedling were observed by Zebda and the lowest was by 13-1. Zebda, Sukkary and Sabre rootstocks recorded higher values of growth parameters than 13-1 rootstock. Husking mango seeds and soaking them in GA_3 prior to sowing improved germination and seedling growth (Shaban, 31). In peach cv. Qiouxiangmi seed dormancy was broken by mechanical scarification, the germination rate being similar to the seed soaked in GA_3 to overcoming seed dormancy. When the seed coat of peach cv. GF 305 was removed a high emergence percentage was observed even without stratification (Tao and Chen, 41). The highest germination (67%) was obtained with fresh papaya seeds washed in water to remove the sarcotesta followed by drying in the shade for 24 hours. Drying in the sun was detrimental (15% germination compared with 59% for shade drying) as was a 30 minutes dip in hot water (Sippel and Classens, 39).

Effect of Acid Scarification

Scarification of seeds with concentrated acids, especially sulphuric acid, greatly increased germination of guava seeds, recording 98% germination. The control seeds soaked in cold water gave 20% germination, while pre-treatment with gibberellic acid gave 65% germination. Seeds soaked in hot water did not germinate at all (Essien, 8). The soaking of seeds in concentrated sulphuric acid for 2-3 minutes was very effective for good germination (Pandey and Misra, 24). The acid scarification and boiling in hot water for 5 minutes of seeds shortened the time required for germination without any adverse effect on germination percentage (Hayes, 12). The soaking of seeds of Allahabad Safeda and Red Fleshed in water for 12-72 hour and in sulphuric acid, hydrochloric acid and nitric acids for 3-12 minutes. Soaking in water for 12 hours and in hydrochloric acid for 3 minutes improved the germination percentage to over 90%, compared with 58% for untreated control (Singh and Soni, 35). Seeds (from ripe fruits) placed in plastic bags were stratified at 5°C for 0, 10, 20 or 30 days or they were scarified either by immersion in concentrated sulphuric acid for 15 minutes or by abrasion with sand for 15 minutes. After treatment, the seeds were germinated at a constant 25°C or at room temperature, either on paper or in sand. A combination of scarifying in sand and germinating

in sand gave the best total germination (98.15%). Germination generally occurred between 8 and 11 days after sowing (Tavares *et al.,* 42). Seeds of guava were subjected to ten different treatments namely, naked seeds, 24 hours water soaking, 48 hours water soaking, 24 hours hot water (40°C) soaking, 24 hours hot water (5% sulphuric acid) soaking, 24 hours water leaching, 24 hours gibberellic acid (100 ppm) soaking, seed scrapping and seed coat breaking. In case of Indian Olive and Jujube, besides the above treatments additional treatments of seeds with flesh were considered. Observation indicated that acid treated seeds showed best performance in respect of seed germination and seedling vigour. While with Jujube and Indian Olive scrapped seeds and 24 hours water soaked seeds showed best performance (Rahman and Quadir, 28). The effects of seed size (small, medium and large) and pre-sowing treatment (soaking in H_2SO_4 for 10 minutes then washing with water, soaking in H_2SO_4 for 10 minutes then in 1% thiourea for 12 hours, mechanical cracking of seeds, chilling for 24 hours in the refrigerator and soaking in water for 24 hours, control) on the seed germination and seedling growth of ber were studied. The greatest seed germination was obtained with the use of medium seeds (50.93%) and treatment with H_2SO_4 for 10 minutes (54.22%). The mechanical cracking of seeds resulted in the lowest number of days to germination (23.66 days). The tallest seedlings were obtained with medium seeds (25.26 cm) and water-soaked seeds (26.33 cm). Water-soaked seeds and large seeds gave the greatest stem diameters (0.54 and 0.51 cm, respectively) (Singh *et al.,* 36). Seeds of the ber cv. Local Desi Gola were soaked in water for 48 hours (control) or in concentrated sulphuric acid for 3-15 minutes. The seeds were sown at monthly intervals between 20 March and 20 July. Soaking in acid for 6 minutes and sowing on 20 May gave the highest germination (90%). The diameter of the seedling stem (15 cm above ground) at 90 days after sowing was greatest (0.74 cm) after soaking in acid for 6 minutes and sowing on 20 April (Singhrot and Makhija, 38). Ber seeds were soaked in sulphuric acid for 3, 6, 9, 12 or 15 minutes or in water for 48 hours. Unsoaked seeds were used as a control. Seeds were sown in the 1st week of January, March or June at a depth of 2, 4 or 6 cm. Transplanting was carried out at the 2, 4, 6 or 8 leaf stage. Budding was done 90 days after sowing on seedlings that were 0.53, 0.65 or 0.75 cm in diameter at a height of 10, 20 or 30 cm above ground level. The 6 minutes soak in sulphuric acid resulted in highest percentage germination at all sowing dates (36.6-71.3%). Germination success increased from January to June and decreased with increasing depth of sowing. Budding success decreased with increasing plant diameter and budding height, greatest budding success (93.5%) was obtained with 0.53 cm diameter seedlings budded at 10 cm above ground level (Chattopadhyay and Dey, 4).

Effect of Chemical Treatment

Plant hormones play a key role in fruit crop production by influencing directly or indirectly various plant processes like germination, rooting, growth and productivity. The some plant growth regulators have been helpful in germination of guava seeds by increasing water uptake and exerting an effect on membrane permeability. These results indicate that use of plant growth regulator might have helped to break the embryo dormancy and induction of synthesis of alpha amylase and other hydrolytic enzymes (Looney, 16). The pre-sowing soaking improved seed germination of guava seeds up to 60% with GA_3 100 ppm in comparison to 46% in untreated seeds (Kumar *et al.,* 15). Seeds of guava cv. Allahabad Safeda were treated by soaking in water for 24 h, in boiling water for 3 minutes, in GA_3, Ethrel or Thiourea for 12 hours or in concentrated HCl or H_2SO_4 for 3 minutes. Seeds were then washed with distilled water before sowing in polyethylene bags. Maximum germination, 6 weeks after sowing was obtained with seeds soaked in 3000 ppm GA_3 (83.2%) followed by seeds soaked in water (80.1%). These results were significantly higher

than those obtained with other treatments and with untreated controls (53.0%). Soaking seeds in 3000 ppm GA_3 also resulted in the greatest plant height, number of leaves/plant and leaf size recorded 5 months after sowing. Seed treatment with boiling water was lethal (Chandra and Govind, 3). The highest germination rates after 1 and 17 months from ber seeds treated with 200 ppm GA_3 (98.76 and 77.82 %, respectively) (Hore and Sen, 13). The effects of seed treatments viz., soaking in 100 ppm gibberellic acid, 1% thiourea, 1000 ppm maleic hydrazide, 1% potassium orthophosphate and 10-3 M ferulic acid for 12 hours, on the germination and growth of jackfruit. The highest germination percentage (95.33%) and coefficient of velocity of germination (27.67), tallest plants (26.78 cm), shortest span of germination (13 days) and fastest germination (average of 3.61 days) were recorded for 100 ppm GA. (Singh *et al.*, 37) concluded that treatment of seeds with 1000 ppm maleic hydrazide gave the highest stem diameter (2.56 cm). Seeds of a local jackfruit cultivar were used fresh or stored at 6°C for 15 days. Seeds were then soaked in solutions of NAA (10, 25 or 50 ppm) or GA_3 (50, 100 or 250 ppm) or in distilled water (control) for 24 h before being sown. Growth regulator treatment did not affect percentage germination, time taken for germination or survival percentage of seedlings in the field. Fresh seeds had a higher percentage germination (66.0 vs. 62.1%), more rapid germination (15.1 vs. 16.7 days) and higher seedling survival percentage in the field (63.9 vs. 59.6%) than stored seeds (Chiesotsu *et al.,* 5).

Karonda seeds, treated with GA_3 at 25-100 ppm for 24 h, were planted and germination was assessed 43, 50 and 58 days later. Germination after 43 days was 0.4% in the control and 1.6-6.8% in the treated seeds. On the 58^{th} day control germination was 49.2% and in seeds treated with GA_3 at 25 ppm it was 67.0%. This treatment (Bankar, 1) also gave good seedling vigour (19.6 cm high compared with 12.2 cm in the control). Papaya seeds collected from unripe fruits in Somalia were submitted to various treatments. They were desiccated in the sun or in the shade for 3, 6, 9, 12 or 15 days and then stored in paper bags at 20°C for 2 months. The effects of removing the sarcotesta and soaking in 300 ppm GA_3 for 24h were examined. Germination percentage increased in seeds desiccated in the shade and treated with GA_3 while average germination time decreased as the duration of the desiccation increased in seeds deprived of their sarcotesta and treated with GA_3 (Bertocci *et al.,* 2). Aonla seeds were soaked in distilled water, 250, 500 or 750 ppm GA_3 or 250, 500 or 750 ppm thiourea prior to germination in Petri dishes. Controls received no soaking treatment. The highest percentage germination (75.98% after 35 days, compared with 50.76% in controls) was obtained in the 250 ppm GA_3 treatment. This treatment also resulted in the greatest plumule and radicle lengths (11.56 and 5.97 cm, respectively, 35 days after sowing) but the thiourea treatments resulted in the most roots/seedling, the highest number (3.60, 35 days after sowing) being obtained in the 750 ppm treatment (Dhankhar *et al.,* 6). Seeds of Aonla were soaked for 12 h in 100-400 ppm gibberellic acid (GA_3) or water, or not soaked (controls). Treatment with 400 ppm GA_3 resulted in the highest percentage germination (87.25%, compared with 56% and 46.25% in seeds soaked in water and controls, respectively). Seedling development (plant height, number of leaves/plant and root development) was best following seed treatment with 400 ppm GA_3 (Wagh *et al.,* 43). Aonla (cv. Gujarat Aonla 1) seeds were treated with 250, 500 or 750 ppm gibberellic acid (GA_3) or thiourea. Seed germination was earliest and percentage germination was highest (75.98% and 64.14% in the laboratory and in pots) in seeds treated with 250 ppm GA_3. This treatment also gave the best results in terms of plumule and radicle length, seedling height (28.84 cm 75 days after sowing), seedling girth (0.90 cm 75 days after sowing) and seedling fresh and dry weight. Treatment with 750 ppm thiourea resulted in the highest number of roots (Dhankhar *et al.,* 7). The

effect of pre-germination seed treatments on the germination and vigour of Aonla seeds were studied. The treatments included gibberellic acid (GA_3) at 50 and 100 ppm, soaking in water for 24 hours and hot water soaking at 60°C for 5 minutes. GA_3 at 50 and 100 ppm increased the percentage seed germination. The tallest plants were obtained following seed treatment with 100 ppm GA_3 and soaking for 24 hours (Pawshe *et al.,* 25).

The effect of seed treatments with growth regulators (250 and 500 ppm GA_3, 250 and 500 ppm thiourea), chemicals (sulphuric acid) and distilled water on seed germination of wild ber (*Zizyphus nummularia*) were studied and the highest percentage of seed germination was recorded with 500 ppm GA_3. A maximum plant height (34.39 cm), plant girth (1.43 cm) and internode length (1.40 cm) were recorded with 250 ppm GA_3. In a related study, the combined effect of seed treatments and foliar applications of growth regulators GA_3 and maleic hydrazide (MH) at 50 ppm) on seedling growth of wild ber was assessed. Foliar spray of 50 ppm GA_3 on seedlings obtained from different seed soaking treatments accelerated seedling vigour. GA_3 gave maximum plant height (56.29 cm), plant girth (2.75 cm) and internode length (2.69 cm). Foliar spray of 50 ppm MH reduced plant height and internode length (Rajwar *et al.,* 29). The combined effect of stratification with hydrogen peroxide (H_2O_2) or gibberellic acid (GA_3) pre-treatments on seed germination in peach and three different wild almond species (*Prunus scoparia, Prunus communis*, and *Prunus haussknechtii*) was investigated by Imani et al., (14). Seeds with shells were rinsed three times for 2 minutes each in sterile distilled water and then imbibed for 24 hours in either distilled water (control), H_2O_2 (0.5 and 1%, 24 h) or GA_3 (250 and 500 ppm, 30 min). Treated seeds were then stratified at 7ºC for 1 to 9 weeks. The number of germinated seeds was recorded weekly for each species. There were significant differences in the percentage and time of seed germination between species and treatments although germination was earlier and more uniform in the treated seeds in comparison with the control in all species. The most effective pre-treatments for breaking dormancy during subsequent stratification were 0.5% H_2O_2 (*Prunus scoparia*), 500 ppm GA_3 (*Prunus haussknechtii*) and 250 ppm GA_3 (*Prunus persica*) Zhang and Xia (44) carried out an experiment with seeds of *Prunus persica* collected from wild trees. Before stratification, seeds were separately soaked in water with different concentrations of GA for 2 and 4 days. All concentrations of GA promoted seed germination. Germination increased by 15% after soaking in 1500 mg GA/ml for 4 days (Zhang and Xia, 44). The effects of gibberellic acid (GA) and ethrel on sapota cv. Kalipatti seed germination and seedling growth. Cracked seeds were soaked for 24 h in 100 ml solution on GA, ethrel and GA+ethrel (at 200, 300 and 400 ppm). Pre-soaking of seeds in GA at 400 ppm+ethrel at 400 ppm resulted in high (90%) and early (12.15 days) germination and the highest emergence rate. Seedlings raised from seeds presoaked on 400 ppm GA_3 produced the highest shoot and root length. The number of leaves per seedling and seedling vigour were highest in seedlings raised from seeds pre-soaked in GA + ethrel (Pampanna and Sulikeri, 22). The effect of pre-soaking treatments, application of growth promoting substances and method and season of grafting on seed germination and growth enhancement of *Khirnee* rootstock and graft success in sapota. To improve the seed germination of *Khirnee* rootstock, seeds were subjected to pre-soaking treatments for 24 h in gibberellic acid (GA_3) at 100 and 200 ppm, thiourea and KNO_3, each at 1 and 2%, cow dung slurry and water. Pre-soaking of *Khirnee* seeds in cow dung slurry for 24 h resulted in the highest (66.83%) seed germination. To enhance the growth rate of *Khirnee* seedlings to attain graftable size rootstock, an experiment was carried out, consisting of GA_3 at 100 and 200 ppm, extracts of neem cake, *Pongamia* and cow dung, vermicompost (Vermiwash),

triacontanol at 0.1 and 0.2% and a control. *Khirnee* seedlings sprayed with GA_3 at 200 ppm on the 3rd and 6th months enhanced the seedling growth (Shirol *et al.*, 32).

Future Aspects

To meet the growing demand of planting material (grafts), nursery man has to produce more number of rootstocks with graftable size in a shorter time. It is, therefore, highly essential to accelerate the seed germination and growth of seedlings with pre-sowing treatments to attain graftable size earlier and reduce the nursery cost. Therefore, enhancement of seed germination is important in propagation and breeding programmes, as well as for testing and using germplasm. In this aspect pre-sowing treatments seems to be the most promising in many fruit species. Therefore, it can be concluded that pre-sowing treatments are effective to get higher germination and better seedling growth of fruit crops.

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RESPONSE OF BIO-ORGANIC NUTRITION ON GROWTH, YIELD AND QUALITY OF ASHWAGANDHA (*Withania somnifera Dunal*.)

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ABSTRACT : In an experiment conducted on ashwagandha (*Withania somnifera* Dunal), to study the response of different organic amendments with organic manure (FYM) and bio-fertilizers in relation to plant growth, root yield and quality parameters it was found that the seedlings (5-7 leaf stage) inoculated with *Azospirillum* @ 10^5 or 10^6 CFU resulted a significant increase in plant growth and biomass yield. However, the root and seed yields were observed higher in the plants planted in soil amended with vermi-compost and FYM @ 2 or 3 kg / 1.8 m^2 /plot. The plant height varied significantly among all the treated plots but remain taller (24.80 cm) in plots treated @ 2kg FYM having maximum stem diameter (0.48 cm) at 30 DAP (days after planting) and highest numbers of leaves per plant (438) after reaching 75 DAP followed by seedling treated with *Azospirillum* @ 10^6 CFU. However, the lowest number of leaves per plant (97.4) was observed in the plants grown in plots amended vermi-compost @ 2kg / plot. Number of branches per plant remained highest (51.0) with plants treated with *Azospirillum* @ 10^6 CFU, soil amended with vermi-compost @ 2kg and FYM @ 3 kg/ plot followed by plants grown with *Azospirillum* @ 10^5 CFU (46.0). Whereas, the plants grown in plots amended without FYM produced least number of branches (21.2) even at 75 DAP. Fresh root weight per plant was observed maximum (24.0 g) in the plants amended with vermi-compost @ 2kg and FYM @ 3kg/plot and inoculated with *Azospirillum* @ 10^6 CFU. However, the dry weight of the roots remained highest (7.6g /plant) in the plants treated with FYM @ 3kg , vermi-compost @ 2 kg / plot and inoculated with *Azospirillum* @ 10^5 CFU.

Keywords : *Withania, seeds, root, alkaloid, withanaloid.*

India is known as a treasure house of medicinal and aromatic plants for ages. Medicinal plants have been classified as trees, shrubs, woody perennials, annuals and biennials, and climbers. Their distribution spreads all over India, Baluchistan, and Punjab and in Sind in the Indian sub-continents. Several of these grow abundantly in the drier parts of India ascently to 5500 ft in Himalayas. Among the perennials, Ashwagandha is very well adapted to grow under subtropical and dry climate in well drained, sandy loam or light red soils having ph of 7.5 to 8.0 with an average rainfall of 600-750 mm. Ashwagandha is being cultivated on large scale as medicinal plant, especially on marginal lands in several districts of Madhya Pradesh, covering an area of more than 4000 hectares (Nigam, 8). In the recent years, cultivation of Ashwagandha has been extended to the areas of Kota in Rajasthan, foot-hills of Punjab and Himachal Pradesh and Tarai regions of Uttarakhand and Uttar Pradesh. Commercial cultivation, being on priority for high returns needs a sustained and agronomic package for production of economically safe raw material for pharmaceutical industry on large scale. Owing to the increased demand for organic and safe products in the market as ashwagandha roots, leaves and seeds are used in formulation of various *Ayurvedic* and *Unani* medicines, there is prudent to cultivate this crop with an application of Vermi-compost and FYM along with a beneficial free-living soil bacteria usually applied as plant growth promoting *Rhizobacteria* or PGPR in the formulation as strains of *Azospirillum*, which lives in close association of plant roots and enhance plant growth by its ability to fix atmospheric nitrogen, production of indole acetic acid, siderophore, nitrate and single molecules resulting in an

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increased mineral uptake in the plant roots (Bashan and Holguin, 4).

It has been proven that various strains of *Azospirillum* are capable of promoting the yield of economically important medicinal and aromatic crops in different soils and climatic regions, using various strains of *A. brasilense* and *A. lipoferum* and cultivars of different species of plants (Bashan and Levanony, 3). Several field experiments have revealed a significant increase in different plant growth parameters including grain yield recorded under all levels of treatments of nitrogen due to Azospirillum inoculations over those un-inoculated and proved the importance of use of bio-fertilizer (Okon and Labandera-Gonzalez, 10). In *Azospirillum* application has also increased the nitrogen availability in soil through biological nitrogen fixation resulting in the promotion of cell division and synthesis of organic compounds in leaves, ultimately increasing the biomass and root yield (Arul, 2) and consequent increase in total alkaloid content in various plant parts including roots (Srivastava *et al.* 15).

The application of inorganic nutrients may not significantly influence the various economic traits in contradiction due to the fact that biosynthesis of secondary metabolites is under genetic control to influence plant growth and seed yield in various responsive crops including Ashwagandha as reported by Umrao *et al.* (16) but the development of a reliable and consistent inoculation technology determines that the application of *Azospirillum*, FYM and Vermi-compost, interaction beneficial with regards to a biological model for fundamental studies on symbiotic associations between them to have a significant impact in future agricultural production. Therefore, the present experiment was conducted to see and evaluate a response of bio-organic nutrition through a application of FYM, Vermi-compost and *Azospirillum* in Ashwagandha (*Withania sominifera* Dunal.).

MATERIALS AND METHODS

The present experiment was carried out at the experimental fields of Ch. Shivnath Singh Shandilya (P.G.) College, Machhra, Meerut (U.P) during the two consecutive years viz. 2005-06 and 2006-07 on Ashwagandha (*Withania somnifera*) cv. Jawahar-20 under the field conditions using of FYM (Farm Yard Manure), Vermi-compost and *Azospirillum*. The experiment was laid out in the factorial RBD under three replications. The ingredients of experimental field were kept in the combinations comprising of FYM, (0 kg/plot (F_0), 2 kg/plot (F_1) or 3 kg/plot (F_3), Vermi-compost 0 kg/plot (V_0), 2 kg/plot (V_1) or 3 kg/plot (V_2) and *Azospirillum* 0 CFU/plot (AZ_0), 10^5 CFU/plot (AZ_1) or 10^6 CFU/plot (AZ_2).

Extraction of total alkaloid and withanaloid content was done employing the 'Gravimetric method taking a sample of 10 g of fine powdered roots in methanol immersed in 'Soxhlet Apparatus' for 6 h. After removal of the methanol from the flask a residue was then filtered with N/2 H_2SO_4 consequently, five times and brought to 7 pH by adding 20% KOH solution @ 11.5 pH. The resultant residue was washed out to diluted chloroform to purify available alkaloid content and finally the left over chloroform layer was water-distilled by rejecting the aqueous solution. Alkaloid and withanaloid (%) were pre-weighed and dried to a constant weight; and finally recorded as total withanaloid content. The package and practices of cultivation under experimental field were followed as per standard recommendations. The data on plant growth, yield and quality parameters were analyzed for least errors by the methods as suggested by Panse and Sukhatme (11).

RESULTS AND DISCUSSION

The results obtained from the investigations carried out on ashwagandha cv Jawahar-20 to study the response of bio-organic nutrition employing an admixture of Vermi-compost and FYM @ 2, 3 kg/plot, respectively and plants inoculated with *Azospirillum* @ 10^5 and 10^6 CFU before transplanting revealed that all the plant growth, root yield and quality parameters differed significantly among plots amended with bio-organic

amendments. The plant height was recorded maximum (84.4 cm) in the plants treated with Vermi-compost @ 3 kg/plots, FYM @ 2 kg/plot and inoculated with *Azospirillum* @ 10^6 CFU and minimum (58.9 cm) in the plants applied with Vermi-compost @ 3 kg and FYM @ 2 kg per plot without inoculation of *Azospirillum* (Table 1). Stem diameter was maximum (0.815 cm)in the plants treated with Vermi-compost @ 3 kg per plot and FYM @ 3 kg/plot and inoculated with *Azospirillum* @ 10^5 CFU whereas, minimum (0.54 cm) applied with Vermi-compost @ 2 kg/plot without FYM applied and inoculation of *Azospirillum*. Number of leaves/plant was recorded maximum (384.4) in the plants treated with Vermi-compost @ 3 kg/plot, FYM @ 2 kg/plot and an inoculation of plant with *Azospirillum* @ 106 and minimum (160.1) in the plants inoculated with *Azospirillum* @ 105. However, untreated plants recorded (124.2 leaves), significantly higher than the lower value. Number of branches recorded was maximum (45.6) in the plants treated with Vermi-compost @ 3 kg/plot, FYM @ 2 kg per plot and *Azospirillum* @ 10^5 inoculation and minimum (21.1) in the plant applied with Vermi-compost @ 3 kg/plot and an inoculation of *Azospirillum* @ 10^6 CFU without FYM application. Plant canopy (cm^2) was recorded maximum (4.165 cm^2) in the plants grown after inoculation with *Azospirillum* @ 10^6 CFU alone and minimum (2.075 cm^2) in the plants raised in the plots amended with FYM @ 3 kg/plot and an inoculation of plants with *Azospirillum* @ 10^5. Leaf area (cm^2) recorded was maximum (67.43 cm^2) in the plants treated with Vermi-compost @ 3 kg, FYM @ 3 kg each per plot and inoculated with *Azospirillum* @ 10^5 and minimum (33.36 cm^2) in plants grown with plots amended with Vermi-compost @ 3 kg/plot and inoculated with *Azospirillum* @ 10^6 CFU without FYM application. Number of berries/plant was recorded maximum (115.4) in the plants grown in the plots amended with Vermi-compost @ 3 kg/plot, FYM @ 2 kg/plot and inoculated with *Azospirillum* @ 10^5 CFU whereas, minimum (19.5) was recorded in untreated plants which remained at par (21.2) with those inoculated with Azospirillum @ 105 alone. Number of seeds/berry was recorded maximum (46.8) in plants treated with *Azospirillum* @ 10^5 alone without the application of admixture of Vermi-compost and FYM and minimum (27.6) in the plants raised in the plots amended with Vermi-compost @ 3 kg/plot, FYM @ 2 kg/plot and inoculation with *Azospirillum* @ 10^5. Main root length per (Table 2) plant was noted maximum (20.9 cm) in the plots treated with FYM @ 3 kg/plot and plants inoculated with *Azospirillum* @ 10^6 CFU without an amendment of the soil plots with Vermi-compost and minimum (12.6 cm) in the plant treated with FYM @ 3 kg/plot and inoculation of plants with *Azospirillum* @ 10^5. Number of primary roots/plant was recorded maximum (5.3) in the plants grown in the beds admixed with Vermi-compost @ 3 kg/plot, FYM @ 2 kg/plot and inoculated with *Azospirillum* @ 10^5 whereas, minimum (1.55) in the plants treated with FYM @ 2 kg/plot and inoculated with *Azospirillum* @ 10^6. Number of secondary roots was noted maximum (6.6) in the plants treated with Vermi-compost applied @ 2 kg/plot and inoculated with *Azospirillum* @ 10^6 without the application of FYM. However, a minimum secondary roots (3.7) were noted for the plants grown in the beds amended with Vermi-compost @ 2 kg/plot and FYM @ 2 kg/plot. Secondary root length was recorded maximum (7.07 cm) in the plants treated with Vermi-compost @ 3 kg/plot and FYM 2 kg/plot and inoculated with *Azospirillum* @ 10^5 and minimum (3.41 cm) in the plants treated with Vermi-compost @ 2 kg/plot and FYM @ 2 kg/plot.

Fresh root weight/plant (Table 2) was obtained maximum (28 g) in the plants treated with Vermi-compost @ 3 kg/plot and FYM @ 3 kg/plot and an inoculation of *Azospirillum* @ 10^5 and minimum (11.75 g) with plants administered soil beds with Vermi-compost @ 2 kg/plot alone. Dry root weight/plant was obtained maximum (7.47 g) from the plants grown in beds applied with Vermi-compost @ 3 kg/plot and FYM 2 kg/plot and inoculation of *Azospirillum* @ 10^5 CFU. Whereas,

Table 1: Plant growth, flowering and seed yield parameters of Ashwagandha (*Withania somnifera* Dunal.) as influenced by different bio-organic treatments.

Treatment	Plant height (cm)	Stem diameter (cm)	Number of leaves/ plant	Number of branches /plant	Plant canopy (WxL, cm^2)	Leaf area (cm^2)	No. of berries/ plant	No. of seeds/ berry
V_0 F_0 AZ_0	59.50	0.635	124.20	37.00	3.465	51.53	19.50	29.90
V_0 F_0 AZ_1	61.50	0.675	160.10	27.80	2.550	59.04	21.20	46.80
V_0 F_0 AZ_2	64.00	0.740	189.70	36.10	4.165	59.30	43.60	37.30
V_0 F_1 AZ_0	67.20	0.660	201.00	38.50	3.875	52.43	62.70	33.90
V_0 F_1 AZ_1	66.80	0.700	239.20	22.70	3.190	50.84	45.70	28.80
V_0 F_1 AZ_2	67.00	0.675	257.20	41.60	2.980	56.30	32.50	37.20
V_0 F_2 AZ_0	60.00	0.660	227.60	36.30	3.080	54.22	35.65	33.20
V_0 F_2 AZ_1	64.40	0.670	236.40	27.80	2.075	40.57	62.00	34.50
V_0 F_2 AZ_2	65.80	0.615	262.40	26.40	2.955	56.46	80.80	35.80
V_1 F_0 AZ_0	59.00	0.540	266.30	24.00	2.620	44.93	72.60	28.90
V_1 F_0 AZ_1	63.50	0.640	267.80	29.00	2.590	51.45	21.30	28.10
V_1 F_0 AZ_2	69.00	0.690	276.80	30.10	3.806	47.10	35.80	42.10
V_1 F_1 AZ_0	74.70	0.615	290.20	41.10	2.380	62.28	49.00	28.10
V_1 F_1 AZ_1	79.10	0.675	315.10	30.40	3.175	54.34	41.50	30.50
V_1 F_1 AZ_2	80.00	0.730	370.90	30.80	3.455	50.23	37.30	34.20
V_1 F_2 AZ_0	72.00	0.705	280.20	34.90	3.660	57.73	40.40	37.20
V_1 F_2 AZ_1	77.50	0.730	365.60	25.70	3.505	52.30	65.60	28.60
V_1 F_2 AZ_2	72.00	0.685	383.10	21.20	3.560	42.31	46.50	31.60
V_2 F_0 AZ_0	72.40	0.685	299.30	29.80	3.410	54.52	107.40	29.80
V_2 F_0 AZ_1	69.90	0.590	302.80	29.00	2.415	40.22	45.00	31.30
V_2 F_0 AZ_2	71.00	0.635	311.70	21.10	2.085	33.36	88.90	31.50
V_2 F_1 AZ_0	58.90	0.620	321.90	22.20	2.885	56.22	52.30	35.10
V_2 F_1 AZ_1	81.00	0.730	378.10	45.60	2.670	62.82	115.40	27.60
V_2 F_1 AZ_2	84.40	0.780	384.40	40.90	2.755	51.33	90.70	33.50
V_2 F_2 AZ_0	72.60	0.740	335.00	39.90	4.155	50.86	97.60	32.00
V_2 F_2 AZ_1	80.20	0.815	365.70	35.40	3.720	67.43	98.50	35.80
V_2 F_2 AZ_2	79.20	0.740	341.70	36.50	3.150	44.57	75.40	32.00
Mean	70.096	0.680	287.200	31.918	3.123	52.025	58.698	33.159
LSD (5%)	4.899	0.055	40.174	5.342	0.641	6.331	6.821	4.430
P (0.001)	**	**	**	**	**	**	**	**

V_0 = Vermi-compost (Control) F_0 = FYM (Control) Az_0 = *Azospirillum* (Control)

V_1 = Vermi-compost (2 kg/plot) F_1 = FYM (2 kg/plot) Az_1 = *Azospirillum* (10^5 CFU)

V_2 = Vermi-compost (3 kg/plot) F_2 = FYM (3 kg/plot) Az_2 = *Azospirllium* (10^6 CFU)

minimum (2.9 g) in the plants treated with Vermi-compost @ 3 kg/plot and inoculation of *Azospirillum* @ 10^6, without FYM application. Fresh root yield/plot (kg) was recorded maximum (0.534 kg) in the plants treated with application of Vermi-compost 3 kg/plot, alone and minimum (0.344 kg) in the plants applied with FYM @ 2 kg/plot and *Azospirillum* @ 10^6 CFU. However, untreated plant recorded (0.268 kg) which was significantly higher than the lowest value obtained in the present investigation. Dry root yield/plot was recorded highest and maximum (0.12 kg) in the plants raised in the soil plots amended with Vermi-compost @ 2 kg/plot along with an inoculation of roots with *Azospirillum* @ 10^6. However, a minimum (0.05 kg) was obtained in the plants treated with Vermi-compost @ 3 kg/plot and inoculated with *Azospirillum* @ 10^5 CFU, without applying FYM. Fresh root yield (kg/ha) was obtained maximum (2150 kg/ha) in plants grown in plots treated with FYM @ 2 kg/plot alone and minimum (1075 kg/ha) in the plants in the soil beds amended with Vermi-compost @ 2 kg/plot, alone. Dry root yield/plot (kg/ha) was obtained maximum (690 kg/ha) in the plants grown in the treatments composed of Vermi-compost @ 3 kg/plot and FYM 2 kg/ plot inoculated with *Azospirillum* @ 10^6. Whereas, a minimum (283 kg/ha) in the plants treated with FYM @ 2 kg/plot and inoculated with *Azospirillum* @ 10^5. Fresh and dry root ratio was recorded highest and maximum (5.95) in the plants grown in the plots amended with Vermi-compost @ 3 kg/plot and plant roots inoculated with *Azospirillum* @ 10^6 and minimum (2.5) in the plants raised with admixing the Vermi-compost @ 2 kg/plot, alone. These findings are in close agreement with those obtained by and Nigam *et al*. (9) and Patidar *et al.* (13) in ashwagandha. It is evident from the findings that the higher application of bio-organic nutrients might have led to the improved production potential of crops determining the plant growth and development (Marschner, 5). The elemental response of available nutrients leading to the complementary effect, might have increased the plant growth attributes indirectly by taking part in the chlorophyll bio-synthesis process after its association into chlorophyll precursor's glycine as glutamine (Mishra and Srivastava, 6) production in the treated plants as reported by Singh *et al.* (14).

The varying data recorded on root growth and quality parameters were noted significant in our findings. The accumulation of total alkaloid content and withananoid in the roots were significant with an application of vermi-compost, FYM and Azospirillum inoculation, expressed remarkable complimentary effects on the traits, which might be due to slower release of nutrients and a long duration of crop. Although a transitional change in the chemical constituents is reported at different harvesting dates (Patel *et al.* 12) but in our results it is harvested once and only on full maturity of the crop owing to the recorded higher values that might be due to an oxidation of starch and its conversion into alkaloids and production of more precursory compound to accumulate more withanaloids in the thicker plants and heavy roots under the different treatments composed of Vermi-compost and FYM @ 3 kg each per plot and growth an inoculation of *Azospirillum* @ 10^5 CFU in the current investigation. Contrary to these findings, the nitrogen amendments through inorganic source of fertilizers are known to responds poorly as reported by Muthumanickam and Balakrishnamurthy (7). It is however, expressed (Agarwal *et al.,* 1), that a significant influence on increased root length and yield were due to favourable environmental conditions, prevailing during the initial growth, flowering and fruiting stage extending the longer growing period of the crop.

The total alkaloid content (%) in the plant roots was recorded maximum (0.759%) in the plots treated with a mixture of Vermi-compost @ 3 kg/plot and FYM @ 2 kg per plot along with an inoculation with *Azospirillum* @ 10^6. However, the minimum alkaloid content (0.39 %) was noted in the plant roots raised with Vermi-compost @ 2 kg/plot, applied alone. However, the untreated plant recorded a content (0.387 %) that remained

Table 2: Root yield and quality parameters of Ashwagandha (*Withania somnifera* Dunal.) as influenced by different bio-organic treatments.

Treatment	Main root length (cm)	No of Primary roots/ plant	No of secondary roots	Secondary root length (cm)	Fresh root weight /plant (g)	Dry root weight /plant (g)	Fresh root yield /plot (kg)	Dry root yield /plot (kg)	Alkaloid content (%)	Withanaloid content (%)
V_0 F_0 AZ_0	14.30	2.60	6.10	4.18	19.50	4.960	0.268	0.080	0.387	0.308
V_0 F_0 AZ_1	15.00	2.55	5.20	5.09	20.50	5.195	0.405	0.115	0.457	0.330
V_0 F_0 AZ_2	16.70	3.90	5.70	6.05	21.50	5.165	0.329	0.095	0.450	0.342
V_0 F_1 AZ_0	16.30	4.30	6.40	5.43	23.00	5.050	0.470	0.085	0.554	0.368
V_0 F_1 AZ_1	16.90	4.80	5.35	6.24	17.70	3.250	0.347	0.055	0.584	0.378
V_0 F_1 AZ_2	16.70	1.55	5.90	4.18	16.50	5.090	0.344	0.085	0.571	0.392
V_0 F_2 AZ_0	17.20	2.70	5.45	5.12	21.00	5.115	0.397	0.085	0.595	0.418
V_0 F_2 AZ_1	12.60	2.20	4.90	4.27	14.50	4.725	0.359	0.075	0.621	0.452
V_0 F_2 AZ_2	20.90	2.90	4.45	6.30	17.00	5.250	0.460	0.095	0.648	0.468
V_1 F_0 AZ_0	15.60	2.35	4.60	3.53	11.75	4.905	0.430	0.095	0.390	0.322
V_1 F_0 AZ_1	14.60	3.30	5.15	5.06	18.50	6.090	0.351	0.095	0.433	0.348
V_1 F_0 AZ_2	17.70	2.65	6.60	6.49	21.50	6.390	0.425	0.120	0.533	0.397
V_1 F_1 AZ_0	14.80	2.95	3.70	3.41	21.50	5.015	0.424	0.105	0.571	0.404
V_1 F_1 AZ_1	16.30	2.15	6.30	5.83	20.50	5.285	0.439	0.095	0.624	0.440
V_1 F_1 AZ_2	14.80	2.30	5.05	4.39	17.50	4.780	0.410	0.085	0.642	0.453
V_1 F_2 AZ_0	14.70	2.44	4.30	4.25	20.50	4.515	0.456	0.095	0.583	0.470
V_1 F_2 AZ_1	14.50	4.20	5.05	6.04	15.75	4.670	0.431	0.115	0.645	0.481
V_1 F_2 AZ_2	15.40	2.10	5.40	4.52	18.50	4.540	0.441	0.075	0.647	0.519
V_2 F_0 AZ_0	16.50	5.10	4.35	5.91	20.00	5.075	0.534	0.095	0.531	0.330
V_2 F_0 AZ_1	17.30	2.50	5.25	4.26	19.75	5.125	0.365	0.050	0.585	0.362
V_2 F_0 AZ_2	14.10	1.75	4.85	6.06	14.75	2.900	0.449	0.085	0.601	0.387
V_2 F_1 AZ_0	17.30	2.30	4.50	5.30	17.50	4.755	0.472	0.095	0.552	0.449
V_2 F_1 AZ_1	14.00	5.30	5.70	7.07	17.75	7.470	0.450	0.075	0.725	0.475
V_2 F_1 AZ_2	15.50	1.70	6.55	5.02	20.50	4.145	0.450	0.085	0.759	0.579
V_2 F_2 AZ_0	14.56	1.70	5.45	3.62	22.50	5.320	0.507	0.075	0.640	0.469
V_2 F_2 AZ_1	18.80	2.70	4.80	5.81	28.00	6.130	0.501	0.095	0.688	0.505
V_2 F_2 AZ_2	15.70	2.30	4.80	3.85	19.50	5.190	0.446	0.075	0.657	0.478
Mean	15.880	2.862	5.253	5.087	19.164	5.040	0.421	0.088	0.580	0.419
LSD (5%)	2.523	0.765	1.156	0.822	3.517	0.732	0.041	0.018	0.118	0.095
P(0.001)	**	**	**	**	**	**	**	**	**	**

V_0 = Vermi-compost (Control) F_0 = FYM (Control) Az_0 = *Azospirillum* (Control)

V_1 = Vermi-compost (2 kg/plot) F_1 = FYM (2 kg/plot) Az_1 = *Azospirillum* (10^5 CFU)

V_2 = Vermi-compost (3 kg/plot) F_2 = FYM (3 kg/plot) Az_2 = *Azospirllium* (10^6 CFU)

significantly higher than the lowest value among all the treatments in the experiment. The maximum withanaloid content (0.579 %) was observed in the plants grown in the plots amended with an admixture of Vermi-compost @ 3 kg/plot, FYM @ 2 kg per plot and an inoculation of plant roots with *Azospirillum* @ 10^6 CFU. Whereas, the lowest contents (0.308 %) of withanolid was obtained from the untreated plants. The quantitative determination of total alkaloid and withanolid content in the roots have also been worked out.

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PATH ANALYSIS BETWEEN FRUIT YIELD AND SOME YIELD COMPONENTS IN TOMATO (*Lycopersicon esculeutum* Mill)

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ABSTRACT : Path analysis was performed on plant and fruit characters of fifteen tomato genotypes grown in a two year field experiment to determine for fruit yield, the direct and indirect effects of the following traits: plant height, no. of primary branches/plant, no. of fruits/plant, fruit weight (g), fruit bearing length, fruit length, fruit width and pericarp thickness. Fruit yield per plant was positively and significantly correlated with pericarp thickness, fruit length, fruit weight and no. of fruits/plant, whereas, fruit yield per plant had negative and significant association with days to 50% flowering, plant height, no. of primary branches/plant, fruit bearing length. Path analysis showed that plant height, fruit length, fruit bearing length and pericarp thickness had positive direct effects on fruit yield while other traits under study had strong negative direct effects. The significant positive correlation coefficients of no. of fruits/plant with fruit yield was resulted from positive indirect effects of days to 50% flowering, fruit weight, fruit width and pericarp thickness, while for fruit weight with fruit yield, significant positive correlation resulted from positive indirect effects via days to 50% flowering, no. of fruits/plant and no. of primary branches/plant. Results suggest that indirect selection for days to 50% flowering, fruit weight, fruit width and direct selection for fruit bearing length and pericarp thickness should be primary selection criteria for improving fruit yield in tomato.

Keywords: *Path analysis, correlation, tomato, yield.*

Plant breeding may alleviate the deficiency in vegetable production by developing varieties yielding higher under the severe ecological conditions of dry tracts of West Bengal prevailing in the districts of Birbhum, Bankura and Purulia. For that purpose, superior varieties must be developed by selection among and within populations that have very rich variations in important agronomic traits. The success of selection depends on the choice of selection criteria for improving fruit yield. Yield components do not only directly affect the yield, but also indirectly by affecting other yield components in negative or positive ways. As a trait can affect another trait positively, it can affect some other or all traits negatively (Walton, 24). For that reason, it is clear that correlation coefficient, which measures the simple linear relationship between two traits, does not predict the success of selection. However, path analysis determines the relative importance of direct and indirect effects on fruit yield (Bhatt, 5). Path analysis has been used to define the best criteria for selection in biological and agronomic studies (Mishra and Drolsom, 18; Williams *et al.*, 25).

MATERIALS AND METHODS

Two field experiments were carried out during two 'rabi' seasons (the 2004-05 and 2005-06) at the Horticulture Farm of Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati , Birbhum, West Bengal (23°29' N, 87° 42' E)and 58.9 msl). The research field had a loamy sand (utisol) in texture with acidic (pH 4.4) in nature. Fifteen winter tomato genotypes which were improved by selection were used in the experiments. These genotypes were sown in seed bed during the month of November, and the seedlings were transplanted in the main field 25 days after sowing. The experiments were arranged in a randomized complete block design with three replications. Plots were 5m long and consisted of four rows, keeping plant-to-plant and row-row spacing of 0.5m apart.

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Before transplanting, the land was prepared following proper agronomic practices. The field was frequently irrigated, to avoid visible symptoms of draught stress. Weeds and insects were effectively controlled.

Data on various quantitative characters viz. days to 50% flowering, plant height (cm), primary branches per plant, fruit bearing length (cm), fruits per plant, fruit weight (g), fruit yield per plant (g) were recorded. To achieve this, five plants (of two center rows leaving one row in the border areas to avoid border effects) were selected randomly per plot at the beginning of the growth seasons and various stages were recorded using these plants till the end of the growth seasons. Data on days to 50% flowering were recorded on whole plot basis. After harvesting of fruits, data on fruit length (cm), fruit width (cm), and pericarp thickness (mm) were also taken from five randomly selected fruits form each selected plant.

Data collected during two growing seasons on these quantitative characters were pooled and correlation was performed as suggested by Johnson *et al.* (15) and Al-Jibouri *et al.* (2). The relative importance of direct and indirect effects of measured traits on fruits yield was determined by path analysis following the method as suggested Dewey and Lu (10) and Burtan and De Vane (8). In the path analysis, fruit yield was the dependent variable and the rest eight parameters (mentioned above) were considered as independent variables.

RESULTS AND DISCUSSION

Information on correlation and path coefficients and heritability estimates of yield and yield contributing characters, in tomato genotypes, is the first requisite to define selection criteria for developing hybrid varieties. There exists a large variation among the germplasm collections of tomato in the fruit yield. The variation, however, has remained unexplored due to lack of information on the relationships between component traits and their contribution towards yield. Most former studies concentrated on small number of traits, but in this study, morphological and phonological traits have been investigated simultaneously.

Estimates of genotypic and phenotypic correlation coefficients among different pairs of characters of tomato is presented in Table 1. Highly significant and positive (genotypic and phenotypic) correlation coefficients with fruit yield were found for pericarp thickness, fruit length, fruit weight and number of fruits per plant, in that order. In former studies with tomato, fruit length, fruit weight (Das *et al.,* 9; Yadav and Singh, 26; Padma *et al.,* 21; Joshi *et al.,* 16), pericarp thickness (Bharti *et al.,* 4; Bhushana et al., 6; Kumar *et al.,* 17; Joshi *et al.,* 16) and fruits per plant (Dhankar *et al.,* 11; Harer et al., 14; Singh *et al.,* 23) exhibited strong positive correlations with fruit yield.

Fruit yield was negatively and significantly correlated with days to 50% flowering, plant height, primary branches per plant, fruit bearing length at both genotypic and phenotypic level. Our results confirm the findings of Mohanty (19, 20) for primary branches per plant, Padma et al. (21) and Mohanty (19, 20) for plant height, but not for days to 50% flowering.

Positive and significant correlation at both genotypic and phenotypic levels were also observed for days to 50% flowering with plant height, primary branches per plant, fruit bearing length; plant height with primary branches per plant, fruit bearing length; primary branches per plant with fruit bearing length; fruit weight with fruit length, fruit width and pericarp thickness; and fruit length with pericarp thickness. Barman *et al.,* (3), Padma *et al.* (21) recorded positive association between plant height and primary branches per plant. Das *et al.* (9) and Padma *et al.* (21) also reported positive correlation between fruit width and fruit weight.

Significant negative correlation at both the levels in this experiment were observed for days to 50% flowering with fruit weight, pericarp thickness; plant height with fruits per plant, fruit weight, fruit length and pericarp thickness; primary

Table 1: Genotypic (G) and phenotypic (P) correlation coefficients of different characters in tomato.

Characters		Plant height (cm)	Primary branches per plant	Fruit bearing length (cm)	Fruits per plant	Fruit weight (g)	Fruit length (cm)	Fruit width	Fruit yield per plant (g)
Days to 50% flowering	G	0.613**	0.408**	0.800**	-0.209*	-0.551**	0.194	-0.060	-0.607**
	P	0.496**	0.260*	0.616**	-0.182	-0.464**	0.143	-0.060	-0.470**
Plant height (cm)	G		0.580**	0.686**	-0.233*	-0.218**	-0.397**	0.043	-0.587**
	P		0.483**	0.669**	-0.208*	-0.211**	-0.378**	0.041	-0.569**
Primary branches per plant	G			0.483**	0.003	-0.110	-0.422**	-0.559**	-0.437**
	P			0.414**	0.015	-0.101	-0.325**	-0.453**	-0.358**
Fruit bearing length (cm)	G				-0.248*	-0.336**	-0.070	0.021	-0.612**
	P				-0.216*	-0.325**	-0.063	0.023	-0.598**
Number of fruits per plant	G					-0.343**	-0.258*	-0.704**	0.152
	P					-0.316**	-0.217*	-0.596**	0.145
Fruit weight (g)	G						0.263*	0.207*	0.455**
	P						0.253*	0.193	0.436**
Fruit length (cm)	G							-0.081	0.564**
	P							-0.068	0.533**
Fruit width (cm)	G								-0.093
	P								-0.078

*Significant at 5% level, **Significant at 1% level.

Table 2: Genotypic path coefficient analysis showing direct and indirect effects of different characters on fruit yield in tomato.

Characters	Days to 50% flowering	Plant height (cm)	Primary branches per plant	Number of fruits per plant	Fruit weight (g)	Fruit bearing length (cm)	Fruit length (cm)	Fruit width (cm)	Correlation with fruit yield
Days to 50% flowering	**-1.224**	0.291	-0.465	0.239	0.251	0.164	0.043	0.094	-0.607**
Plant height (cm)	-0.750	**0.475**	-0.661	0.265	0.099	0.141	-0.088	-0.068	-0.587*
Primary branches per plant	-0.500	0.276	**-1.139**	-0.003	0.050	0.099	-0.094	0.874	-0.437**
Number of fruits per plant	0.256	-0.110	-0.003	**-1.139**	0.156	-0.051	-0.057	1.100	0.152
Fruit weight (g)	0.675	-0.103	0.125	0.391	**-0.455**	-0.069	0.058	-0.167	0.455**
Fruit bearing length (cm)	-0.980	0;.326	-0.550	0.283	0.153	**0.205**	-0.016	-0.033	-0.612**
Fruit length (cm)	-0.238	-0.188	0.481	0.291	-0.120	-0.014	**0.223**	0.127	0.564**
Fruit width (cm)	0.074	0.021	0.637	0.802	-0.049	0.004	-0.018	**-0.564**	-0.093

Residual = 0.273; * and **Significant at 5% and 1% level, respectively; Diagonal (Bold) values indicated direct effect.

branches per plant with fruit length, fruit width and pericarp thickness; fruit bearing length with fruits per plant, fruit weight and pericarp thickness; and fruits per plant with fruit weight, fruit length and fruit width. Significant negative correlation at both the levels were also found between number of fruits per plant and fruit weight by Mohanty (19, 20), Padma *et al.* (21), Joshi *et al.* (16) and Singh *et al.* (23); between number of fruits per plant and plant height by Mohanty (20).

However, reports on the nature of association between days to 50% flowering with pericarp thickness; plant height with pericarp thickness, fruit length and fruit width; fruit bearing length with fruits per plant, fruit weight and pericarp thickness; fruits per plant with fruit length and fruit width are scanty. Such type of negative association may arise primarily form developmentally induced relationship (Adams, 1) whereby the developing structures of the plant compete for a common factor, possibly limited nutrient supply and if one structure is more favoured than the other for any reason, a negative correlation may arise between them.

In the present investigation, in general the genotypic and phenotypic correlations showed similar trend but genotypic correlation were at higher magnitude than phenotypic correlation in most of the cases. Vary close values of genotypic and phenotypic correlation were also observed between some character combinations which might be due to reduction in error (environmental) variance to minor proportions as reported by Dewey and Lu (10). Wide difference between genotypic and phenotypic correlations between two characters is due to dual nature of phenotypic correlation, which is determined by genotypic and environmental correlation, and heritabilities of the character (Falconer, 12).

Path coefficients divided the correlation coefficient into a series of direct and indirect effects of morphological and phonological traits on the fruit yield of tomato (Table 2). Path analysis showed that only plant height, fruit length, fruit bearing length and pericarp thickness had positive direct effects, in that order, on the fruit yield while other traits had strong negative direct effects. The results are in conformity with Barman et al. (3), Bodunde (7), Singh et al. (22), Joshi *et al.* (16) for plat height; Padma *et al.* (21), Joshi *et al.* (16) and Singh *et al.* (23) for fruit length; and Singh *et al.* (23) for primary branches per plant and fruits per plant.

The main effects of plant height and fruit bearing length were significantly negative and resulted mainly from the negative indirect effects via days to 50% flowering and primary branches per plant, whereas the main effects of fruit length and pericarp thickness were significantly positive and resulted mainly from the positive indirect effects via primary branches per plant, number of fruits per plant, fruit width and fruit weight indicating selection of these traits would be rewarding at least for the present situation. Fruits per plant had high and negative direct effect, but high positive indirect effects through fruit width, days to 50% flowering and fruit weight caused positive correlation. Similarly, fruit weight showed negative direct effect on fruit yield, but due to positive indirect effects via days to 50% flowering, primary branches per plant, fruits per plant and fruit length, the correlation was significantly positive. So for the characters like fruits per plant and fruit weight, the indirect causal factors are to be considered simultaneously for selection, since indirect effects seem to be cause of correlation.

The residual effect (0.273) indicated that the nine characters included in this study explain moderate to high percentage of variation is fruit yield in this population. Moreover, majority of the values of path coefficients are less than unity indicating that inflation due to multicolinearity is minimal (Gravois and Helms, 13).

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EFFECT OF CHEMICALS ON SHELF LIFE AND QUALITY OF GUAVA (*Psidium guajava*) FRUITS CV. APPLE COLOUR

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ABSTRACT: Guava cv. Apple colour is a commercial fruit crop for the grower in India but its self life is poor and its waste causes many economic problems. The aim of this study was to improve the self life of the fruit by the use of different chemicals composition, Waxol percentages and packaging materials. There were ten post harvest treatments—Bavistin (0%), (0.1%) and (2%) and Wax (0%), (6%) and (8%), and one storage condition i.e (Room temperature). Name of chemical use – Their effects were accessed by complete randomized design with three replications. The treated fruits of guava were stored at room temperature. There was decrease in vitamin C (mg) and acidity during storage period of guava fruit under room temperature. The increase in TSS and juice pH and physiological loss in weight of fruit was noticed in storage period irrespective of post harvest treatment and room temperature. All the treatments were found better in respect of TSS & ascorbic acid content over control. On the basis of results obtained the treatment combination T_4 (Waxol 6% + Bavistin 0.2%) proved to be the best in terms of fruit quality and better shelf life at room temperature.

Keywords : *Guava, waxol, polythene bags, carbendazim and LDPE.*

Guava (*Psidium guajava*) is one of the common and major fruit crops of India and considered fourth most important in area and fifth in production. It is rich in vitamin 'C' (300 mg\ 100g) and good source of calcium, phosphorous, pentathenic acid, riboflavin, thiamine and niacin. It is a climacteric fruit and highly perishable in nature and should be marketed immediately after harvest. The short post-harvest life of horticultural crops is due to their highly perishable nature and physiological break down during handling, transport, storage and these losses are further enhanced by infection of post harvest diseases. Various viable technologies for improving shelf-life and storage of horticultual commodities have evolved during the post decades; antitranspirants, wax coating, growth retardants and different type of packing materials etc. increase the shelf- life of harvested fruits. The technology holds considerable promise because in many cases it has an edge over the conventional methods. It could be applied judiciously where conventional methods are inadequate, uneconomical or pose potential health risks. It can also be used as a complementary process with many new and emerging technologies. The process helps in reducing chemical burden on the commodities and also increases the packaging possibilities. But in spite of these available techniques the percentage of post harvest losses of fruit is still high. Therefore, there has to be a standardization of techniques for reducing these post harvests losses in the produce thereby, maintaining the quality of the product. The techniques should be feasible, economically viable and easily affordable to the average growers. It should also be feasible from the health point of view of human beings (Hussain *et al.,* 4). All known methods of foods processing and even storing foods at room temperature for a few hours after harvesting can lower the content of some nutrients, such as vitamins (Aradhita *et al.,* 1).

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MATERIALS AND METHODS

The present investigation to enhance shelf life and quality of guava (*Psidium guajava*) fruit cv. Apple Colour through post harvest application of some chemicals was conducted at Post Harvest Laboratory, Department of Horticulture, Allahabad Agricultural Institute. Allahabad during the year 2008-09. The experiment was laid out in a C.R.D. with nine treatments (Table 1) each replicated

thrice, keeping unit per treatments. The treated fruits of guava were stored at room temperature.

Bavistin and waxol were applied on guava fruits and packed in a polythene bags to extend the shelf life. Regular observations were taken at 4 days interval on physiological loss in diameter of fruit, specific gravity, T.S.S., acidity and vitamin C content.

Table 1: Treatment combinations.

S. No.	Symbol	Treatment combination
1	T_0	Control (Bavistin (0%)+Waxol (0%))
2	T_1	Bavistin (0.1%) + Waxol (0%)
3	T_2	Bavistin (0.2%) + Waxol (0%)
4	T_3	Bavistin (0%) + Waxol (6%)
5	T_4	Bavistin (1 %) + Waxol (6%)
6	T_5	Bavistin (2%) + Waxol (8%)
7	T_6	Bavistin (0.%) + Waxol (6%)
8	T_7	Bavistin (0.1%) + Waxol (8%)
9	T_8	Bavistin (0.2%) + Waxol (8%)

RESULTS AND DISCUSSION

Diameter of fruit (%) :

The results (Table 1) revealed that the effect of different levels of waxol, and interaction (waxol+Bavistin) was significant right from 0, 4, 8 and 12 days of storage. Minimum physiological loss in diameter was recorded with the treatment combination T_0 (Bavistin 0.% + Waxol 0%) *i.e.* 6.60%, 5.90%, 5.65% and 5.20% at 0, 4, 8 and 12 days of storage, respectively followed by T_1 (Bavistin 0.1% + Waxol 0%) i.e. 6.63, 6.23, 5.78% and 5.31%. Maximum physiological loss in diameter was recorded with the treatment combination T_5 (Bavistin 0.2% + Waxol 6%) confirming to results recorded by Jagdeesh, (5) and Teaotia *et al.* (10).

Specific gravity :

It is clear from Table 2 that the effect of different levels of waxol, and interaction (waxol+Bavistin) was significant right from 0, 4, 8 and 12 days of storage. Whereas the interaction of different levels of Waxol + Bavistin was non-significant at 0, 4, 8 and 12 days of storage. Maximum specific gravity was recorded with the treatment combination T_4 (Waxol 6%) + Bavistin 0.1%) i.e. 1.34, 1.15, 1.04 and 1.01 at 0, 4, 8 and 12 days of storage which was followed by T_5 (Waxol 6%) + Bavistin (0.2%) and minimum specific gravity was recorded in control. Similar results were also recorded by Shanker *et al*. (6).

Total soluble solids (%):

Maximum total soluble solids (Table 3) was recorded with the treatment combination T_4 (Waxol 6% + Bavistin 0.1%) *i.e.* 12.49, 11.65, 10.16 and 8.86 at 0, 4, 8 and 12 days of storage which was followed by T_7 (Waxol 1% + Bavistin 0%) and minimum total soluble solids was recorded with control. The results are inconsonance with the work of Goswami *et al.* (3) and Singh *et al.* (7).

Acidity % :

All the treatments showed significant difference for acidity content (Table 4) for different interval of storage periods. Maximum acidity (0.72%) was recorded in untreated (control) fruits followed by other treatment and minimum acidity (0.12%) was recorded with the treatment combination T_4 (waxol 6% + bavistin 0%). This finding is supported by Chen *et al.* (2) and Singh *et al.* (8).

Ascorbic acid (Vitamin C) content (mg/100g) :

It is evident from Table 5 that all the treatments showed significant difference for different interval of storage periods. Maximum vitamin C was recorded with the treatment combination T_4 (Waxol 6% + Bavistin 0.1%) *i.e.* 205.17 mg, 199.46, 173.25 and 153.92 mg at 0, 4, 8 and 12 days which was followed by T_5 (Waxol 6%) + (Bavistin 0.2%) and minimum vitamin C content was recorded with the control fruits. The findings are in support of Singh *et al.* (9) and Ylagan (11).

On the basis of results obtained, the treatment combination T_4 (Waxol 6% + Bavistin 0.2%) proved to be the best in terms of fruit quality and better shelf life at room temperature. Since these finding are based on one year trial and therefore, further experiment may be done to substantiate the results.

Table 1 : Effect of different levels of bavistin, waxol and their interaction on diameter (cm) of guava fruit cv. Apple Colour at different days of storage at ambient temperature.

Bavistin (B)	0 Day Waxol (W)				4th Day Waxol (W)			
	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)
B_0 (0.0%)	6.60	6.83	6.93	6.79	5.90	6.37	6.43	6.23
B_1 (0.1%)	6.63	7.71	7.10	7.15	6.23	6.77	6.58	6.53
B_2 (0.2%)	6.67	7.60	7.07	7.11	6.23	6.73	6.57	6.51
Mean (W)	6.63	7.38	7.03	-	6.12	6.62	6.53	-
	C.D. (P = 0.05)				C.D. (P = 0.05)			
Bavistin (B)	NS				0.022			
Waxol (W)	NS				0.022			
Interaction (B W)	NS				0.038			

Bavistin (B)	8th Day Waxol (W)				12th Day Waxol (W)			
	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)
B_0 (0.0%)	6.60	6.83	6.93	6.79	5.90	6.37	6.43	6.23
B_0 (0.0%)	5.65	5.99	6.00	5.88	5.20	5.35	5.38	5.31
B_1 (0.1%)	5.78	6.35	6.30	6.14	5.31	5.95	5.50	5.59
B_2 (0.2%)	5.98	6.30	6.15	6.14	5.35	5.85	5.50	5.57
Mean (W)	5.80	6.21	6.15	-	5.29	5.72	5.46	-
	C.D. (P = 0.05)				C.D. (P = 0.05)			
Temperature (TE)	0.011				0.040			
Time (T)	0.011				0.040			
Interaction (TE T)	0.019				0.070			

Table 2 : Effect of different levels of bavistin, waxol and their interaction on specific gravity of guava fruit cv. Apple Colour at different days of storage at ambient temperature.

Bavistin (B)	0 Day Waxol (W)				4th Day Waxol (W)			
	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)
B_0 (0.0%)	1.01	1.11	1.12	1.08	5.90	6.37	6.43	6.23
B_1 (0.1%)	1.03	1.34	1.16	1.18	6.23	6.77	6.58	6.53
B_2 (0.2%)	1.07	1.27	1.13	1.17	6.23	6.73	6.57	6.51
Mean (W)	1.05	1.24	1.13	-	6.12	6.62	6.53	-
	C.D. (P = 5%)				C.D. (P = 0.05)			
Bavistin (B)	NS				0.010			
Waxol (W)	NS				0.010			
Interaction (B W)	NS				0.017			

Bavistin (B)	8th Day Waxol (W)				12th Day Waxol (W)			
	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)
B_0 (0.0%)	0.81	0.92	0.94	0.89	0.62	0.78	0.82	0.74
B_0 (0.0%)	0.86	1.08	0.95	0.96	0.71	1.01	0.90	0.87
B_2 (0.2%)	0.88	1.06	0.94	0.96	0.75	0.99	0.89	0.87
Mean (W)	1.05	1.24	1.13	-	0.69	0.92	0.87	-
	C.D. (P = 0.05)				C.D. (P = 0.05)			
Temperature (TE)	0.009				0.008			
Time (T)	0.009				0.008			
Interaction (TE T)	0.015				0.013			

Table 3 : Effect of different levels of bavistin, waxol and their interaction on total soluble solids (%) of guava fruit cv. Apple Colour at different days of storage at ambient temperature.

Bavistin (B)	0 Day Waxol (W)				4th Day Waxol (W)			
	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)
B_0 (0.0%)	10.46	11.77	11.80	11.34	10.02	11.33	11.35	10.90
B_1 (0.1%)	11.70	12.49	12.27	12.15	11.31	11.65	11.43	11.46
B_2 (0.2%)	11.70	12.49	11.85	12.01	11.32	11.65	11.37	11.45
Mean (W)	11.29	12.25	11.97	-	10.88	11.54	11.38	-
	C.D. (P = 0.05)				C.D. (P = 0.05)			
Bavistin (B)			NS				0.04	
Waxol (W)			NS				0.04	
Interaction (B W)			NS				0.06	
Bavistin (B)	**8th Day Waxol (W)**				**12th Day Waxol (W)**			
	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)
B_0 (0.0%)	8.26	9.76	9.83	9.28	6.70	7.17	7.66	7.18
B_1 (0.1%)	9.23	10.16	10.16	9.85	6.95	8.86	8.39	8.07
B_2 (0.2%)	9.65	10.16	9.90	9.90	6.95	8.86	8.12	7.98
Mean (W)	9.05	10.03	9.96	-	6.87	8.30	8.06	-
	C.D. (P = 0.05)				C.D. (P = 0.05)			
Temperature (TE)			0.04				0.07	
Time (T)			0.04				0.07	
Interaction (TE T)			0.07				0.12	

Table 4 : Effect of different levels of bavistin, waxol and their interaction on acidity (%) of guava fruit cv. Apple Colour at different days of storage at ambient temperature.

Bavistin (B)	0 Day Waxol (W)				4th Day Waxol (W)			
	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)
B_0 (0.0%)	0.89	0.60	0.57	0.69	0.86	0.56	0.53	0.65
B_1 (0.1%)	0.80	0.32	0.33	0.48	0.75	0.28	0.29	0.44
B_2 (0.2%)	0.75	0.33	0.56	0.55	0.72	0.29	0.52	0.51
Mean (W)	0.81	0.42	0.49	-	0.78	0.38	0.45	-
	C.D. (P = 0.05)				C.D. (P = 0.05)			
Bavistin (B)			0.163				0.007	
Waxol (W)			0.163				0.007	
Interaction (B W)			NS				0.011	
Bavistin (B)	**8th Day Waxol (W)**				**12th Day Waxol (W)**			
	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)
B_0 (0.0%)	0.91	0.75	0.67	0.78	0.72	0.35	0.26	0.44
B_0 (0.0%)	0.82	0.34	0.48	0.55	0.48	0.12	0.24	0.287
B_2 (0.2%)	0.81	0.35	0.60	0.59	0.46	0.24	0.26	0.32
Mean (W)	0.85	0.48	0.58	-	0.55	0.24	0.25	-
	C.D. (P = 0.05)				C.D. (P = 0.05)			
Temperature (TE)			0.008				0.005	
Time (T)			0.008				0.005	
Interaction (TE T)			0.013				0.009	

Table 5 : Effect of different levels of bavistin, waxol and their interaction on vitamin C content (ascorbic acid mg/100 g pulp) of guava fruit cv. Apple Colour at different days of storage at ambient temperature.

Bavistin (B)	0 Day Waxol (W)				4th Day Waxol (W)			
	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%)	Mean (B)	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)
B_0 (0.0%)	181.38	191.66	191.80	188.28	176.66	184.49	187.59	182.91
B_1 (0.1%)	183.83	205.17	199.68	196.23	178.83	199.46	193.33	190.54
B_2 (0.2%)	190.22	200.10	198.27	196.20	183.83	193.75	191.25	189/61
Mean (W)	185.14	198.98	196.58	-	179.77	192.57	190.72	-
	C.D. (P = 0.05)				C.D. (P = 0.05)			
Bavistin (B)			NS				1.81	
Waxol (W)			NS				1.81	
Interaction (B W)			NS				3.13	

Bavistin (B)	8th Day Waxol (W)				12th Day Waxol (W)			
	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)	W_0 (0.0%.)	W_1 (6.0%.)	W_2 (8.0%.)	Mean (B)
B_0 (0.0%)	146.08	161.69	163.08	156.95	6.70	7.17	7.66	7.18
B_1 (0.1%)	153.95	173.25	170.19	1.65.80	6.95	8.86	8.39	8.07
B_2 (0.2%)	157.73	171.84	164.26	164.61	6.95	8.86	8.12	7.98
Mean (W)	152.59	168.93	165.84	-	6.87	8.30	8.06	-
	C.D. (P=0.05)				C.D. (P = 0.05)			
Temperature (TE)			1.55				1.29	
Time (T)			1.55				1.29	
Interaction (TE T)			2.69				2.23	

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EFFECT OF ETHREL ON POST HARVEST CHANGES IN PAPAYA (*Carica papaya* L.) FRUITS

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ABSTRACT: The present experiment entitled, "Studies on the effect of ethrel on post harvest changes in papaya (*Carica papaya* L.) fruits was carried out to investigate the effect of ethrel on bio-chemical changes occurred during its post harvest life. The objective of this work was to evaluate the effects of various concentrations of Ethrel (500 ppm, 750 ppm, 1000 ppm and 1500 ppm) on shelf life of papaya fruits when stored under ambient conditions. The treated fruits were assessed for physiological changes such as percentage of ripening, loss of fruit weight (kg), biochemical aspects such as TSS (°Brix), titratable acidity (%), total sugars (%), reducing sugar (%), ascorbic acid content (mg/100g), total carotenoids (mg/100g) along with organoleptic evaluation. The observations were recorded at 3, 6 and 9 days after storage and the experiment was laid down using Completely Randomized Design. From the experiment it was clear that the overall performance of the above characteristics was found the best when the fruits were treated with 1500 ppm ethrel followed by 1000 ppm ethrel.

Keywords: *Papaya, ethrel, ripening, shelf life.*

Papaya (*Carica papaya* L.) is one of the major fruit crops cultivated in tropical and subtropical zones of the world. India is the largest producer of papaya in the world contributing about 37% of the papaya produced in the world with a cultivated area of about 106 thousand hectare and the productivity of 39.6 metric tonnes per hectare. The latest production of papaya in India during the year 2010-2011 was 4196 thousand metric tonnes (Anon., 2). It is an abundant source of carotene (2020 I.U./100g), precursor of vitamin A. Papaya fruits are used for the treatment of piles, dyspepsia of spleen and liver, digestive disorders, diphtheria and skin blemishes. Ethrel (2, chloroethyl phosphonic acid) is one of the ethylene releasing substances, known mainly for its ability to induce fruit ripening. Aqueous solution of ethrel is stable below pH 3.5. Above pH 3.5, the hydrolysis of ethrel begins with the release of free ethylene along with chloride and phosphate ions. On dipping the mature fruits in ethrel, it enters into the fruit cells, releases ethylene and hastens the ripening process. Ethrel has been found very effective growth regulator in ripening and improving fruit quality in many climacteric fruits such as banana (Guerra *et al.,* 3), mango (Sampaio, 16), apple (Unreth, 20) and guava (Singh *et al.,* 19). However, very little work has been done so far to study the effect of ethrel on ripening and quality of papaya fruits.

Keeping in view the usefulness of ethrel treatments in fruits as revealed by various scientists, the present study was aimed to evaluate the effectiveness of postharvest immersion in different ethrel concentrations on the postharvest quality attributes of papaya fruit kept at ambient temperatures.

MATERIALS AND METHODS

The present investigation entitled "Effect of ethrel on post harvest changes in papaya (*Carica papaya* L.) fruits" was carried out at Laboratory of the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow during the year 2010 and 2011. The fruits of papaya cv. Pusa Delicious which were physiologically mature and have attained the full size, light green with tinge of yellow at apical end were used for the study. The fruits were selected on the basis of uniformity, maturity, size and shape. The experiment was laid out in

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Completely Randomized Design (CRD) with five treatments and three replications.

The fruits were washed with clean water, dipped for 30 seconds in 0.01% Bavistin and dried with muslin cloth before use.The fruits were dipped for five minutes in the following concentrations of Ethrel solution. i.e. control (T_0), 500 ppm (T_1), 750 ppm (T_2), 1000 ppm (T_3) and 1500 ppm (T_4).

After each treatment, the fruits were air dried at ambient temperature for 30 minutes in an attempt to reduce possible chemical injury. The control fruits were dipped for five minutes in the distilled water without using the ethrel solution. The number of fruits treated under each treatment were twelve, out of which nine fruits were examined for their chemical composition in three replications at the interval of 3 days, 6 days and 9 days after storage. The remaining three fruits were tested for physical characters for the same intervals.

The fruits sampled were assessed for percentage of ripening, weight loss, TSS, titratable acidity, total sugar, reducing sugar, ascorbic acid and total carotenoids and also evaluated by organoleptic test. Percentage of ripening (%) was calculated as per the formula : Ripening (%) = The number of ripe fruit/total number of fruit) x 100 and expressed as a percentage. Weight loss (%)was determined by weighing the fruit in each treatment at different intervals of storage and was expressed as percentage deviation in weight on the basis of initial weight. Titratable acidity, TSS, sugar and ascorbic acid were determined following the method described by Ranganna (13). Total carotenoids was measured by taking 5 grams of the sample, grounded with acetone and anhydrous sodium sulphate in a pestle and mortar (Ranganna, 13). Organoleptic evaluation of five treatment combinations were judged by a trained panel of ten members using a Nine Point Hedonic Scale ('9' Like Extremely and '1' Dislike extremely) following the method of Murray *et al.* (9) for skin colour, flavour, texture, aroma and overall acceptability and the experiment was designed under Completely Randomized Design (CRD) for necessary data collection and statistical analysis. Comparison of treatment means were made with the help of Critical Differences. Duncan Multiple Range Test (DMRT) was used to group the treatment means on the basis of C.D. The values were marked with English alphabets. The alphabet 'a' denoted the maximum value and subsequent lower values in decreasing order were marked alphabeti- cally. The values marked with same alphabet(s) indicated that they were statistically at par.

RESULTS AND DISCUSSION

Effect on Ripening : Present investiga- tion (Table 1) revealed that ethrel application enhanced the onset of ripening in papaya and the response varied according to the concentration. 100% ripening was found when the fruits were treated with ethrel @ 1500 ppm as early as three days after storage. Although it was found that increase in ethrel concentration hastened the ripening process but the effects of ethrel @ 500 ppm, 750 ppm and 1000 ppm were statistically similar with control. All the fruits were ripened at 6 DAS. The mode of action of ethylene on ripening of fruits is not clearly understood. However it was explained by Holl (5) that ethylene probably brings about the climacteric, since in many fruits the rise in respiration is directly preceded by an elevation in the ethylene concentration. This respiratory climacteric can be induced by ethylene treatment without a simultaneous change in tissue permeability. It has also been reported that ethylene alters the proportion of individual transfer RNA species. This effect of ethylene may influence the transfer of m RNA and thus initiate ripening.

Effect on weight loss : Table 1 indicated that the physiological loss in weight was significantly increased with the increase of ethrel concentrations. The maximum weight loss (24.49%) was observed at 1500 ppm where as it was only 14.30% in control at 9 DAS. Similar type of decrease in fruit weight during storage was also observed by Sharma and Singh (18) in dates and Gupta *et al.* (4) in citrus

Table 1: Effect of Ethrel on percentage of Ripening, Loss in weight , Titratable Acidity and T.S.S. of Papaya fruit during storage.

Treatments	Ripening(%)			Loss in weight (%)			Titratable Acid (%)			TSS (°Brix)		
	3DAS*	6 DAS	9DAS	3DAS	6 DAS	9DAS	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS
Control	44.44a	100.00	N.A.	9.27e	12.60d	14.30d	0.400a	0.172a	0.111a	6.93d	11.73c	10.43c
Ethrel @ 500 ppm	44.44a	100.00	N.A.	10.28d	13.76cd	15.99cd	0.313b	0.157b	0.090b	7.07cd	11.90c	10.90b
Ethrel @ 750ppm	55.55a	100.00	N.A.	11.77c	14.75bc	16.80bc	0.267c	0.127c	0.080c	7.37bc	12.37b	11.07b
Ethrel @1000 ppm	61.11a	100.00	N.A.	13.09b	15.44b	18.47b	0.160d	0.104d	0.068d	7.60b	12.67a	11.47a
Ethrel @1500ppm	100.00b	N.A.	N.A.	14.47a	19.17a	24.49a	0.085e	0.064e	0.054e	11.70a	11.07d	8.30d
Mean	61.11	80.00		11.775	15.145	18.010	0.245	0.125	0.080	8.13	11.95	10.43
C.V.	25.39			5.747	6.798	9.202	7.268	1.880	3.199	3.225	1.582	2.052
C.D. (P=0.05)	28.594			0.805	1.261	1.900	0.021	0.003	0.003	0.312	0.225	0.255

*DAS-Days After Storage.
N.A. - not available for the study.
The Tables represent the pooled values of two years data.

Table 2: Effect of Ethrel on Per cent reducing and total sugar, Ascorbic Acid and Total Carotenoids of Papaya fruit during storage.

Treatments	Per cent reducing Sugar (%)			Total sugar (%)			Ascorbic Acid(mg/100g)			Total carotenoids (mg/100g)		
	3DAS	6 DAS	9DAS	3DAS	6 DAS	9DAS	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS
Control	3.55e	5.75c	3.77c	3.55e	5.75c	3.77c	27.20d	42.37c	29.63d	2.34e	2.89c	1.99d
Ethrel @ 500 ppm	4.08d	6.75b	4.19bc	4.08d	6.75b	4.19bc	28.00d	44.59b	36.15c	2.48d	2.91c	2.12c
Ethrel @ 750ppm	4.34c	7.04ab	4.30b	4.34c	7.04ab	4.30b	29.78c	46.22ab	39.70b	2.66c	2.98b	2.21b
Ethrel @1000 ppm	5.40b	7.25a	5.16a	5.40b	7.25a	5.16a	33.33b	47.67a	44.74a	2.75b	3.117a	2.38a
Ethrel @1500ppm	6.36a	5.70c	4.03bc	6.36a	5.70c	4.03bc	44.44a	39.41d	27.56d	2.88a	2.780d	1.86c
Mean	4.75	6.50	4.29	4.75	6.50	4.29	32.55	44.05	35.566	2.622	2.935	2.11
C.V.	3.779	5.983	8.609	3.779	5.983	8.609	4.416	3.296	4.933	1.171	0.886	1.785
C.D. (P=0.05)	0.213	0.462	0.439	0.213	0.462	0.439	1.709	1.727	2.085	0.037	0.031	0.045

Table 3: Effect of Ethrel on Sensory Evaluation on Papaya fruit during storage.

Treat-ment	Colour			Flavour			Texture			Aroma			Overall Acceptability		
	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS	3 DAS	6 DAS	9 DAS
Control	3.83d	6.90c	4.83	4.40d	7.43c	5.57c	4.37c	7.43b	5.43c	4.33c	7.40c	5.47a b	4.13d	6.83d	5.30c
Ethrel @ 500 ppm	3.97c d	7.17b c	5.03	4.57d	7.63b c	5.83b	4.60c	7.60a b	5.67c	4.50c	7.53b c	5.63a	4.27c d	7.13b c	5.70b
Ethrel @ 750ppm	4.50b c	7.40a b	5.33	4.93c	7.83a b	6.10a	5.10b	7.83a b	6.03b	4.60b c	7.70b	5.87a	4.43c	7.30b	5.80b
Ethrel @ 1000 ppm	4.93b	7.84a	5.50	5.27b	8.00a	6.27a	5.33b	8.03a	6.33a	4.83b	8.03a	6.00a	4.70b	7.67a	6.17a
Ethrel @ 1500ppm	8.20a	7.37b	4.80	8.17a	7.13d	5.30d	7.80a	6.80c	5.47c	8.03a	6.97d	5.00b	8.00a	7.00c d	5.20c
Mean	5.09	7.33	5.10	5.47	7.61	5.81	5.44	7.54	5.79	5.26	7.53	5.59	5.11	7.19	5.63
C.V.	9.187	5.117	15.339	3.895	2.967	3.077	5.584	4.934	3.765	4.840	2.286	8.075	3.757	3.476	3.466
C.D. (P=0.05)	0.556	0.446	NS	0.087	0.092	0.213	0.361	0.442	0.259	0.303	0.205	0.537	0.228	0.297	0.232

fruits when dipped in 250-500 ppm ethrel for 5 minutes.

Effect on Titratable Acidity : It is obvious from the present finding (Table 1) that acidity of the papaya fruit was decreased by post harvest application of ethrel and the response varied within the concentrations. Maximum decrease (0.054%) in total acidity was found in fruits treated with 1500 ppm ethrel after 9 days of the treatment.Similar finding was also noted in guava (Singh *et al.,* 19) and in date (Sharma and Singh, 18). Riberau-Gayon (14) suggested that transformation of organic acids into sugars was one of the reasons for deceasing organic acids during fruit ripening. Therefore, another possibility seemed that ethrel might enhance the conversion of organic acids to sugars since present findings revealed that sugar content was increased and acidity was decreased following ethrel application.

Effect on Total Soluble Solids : The maximum T.S.S. (11.87°Brix) was observed in 1500 ppm after 3 days of the treatment which was at par with in 1000 ppm treated fruits (12.67%) after 6 days of the treatment. Similarly, increased total soluble solids due to post harvest application of ethrel was also reported by Singh *et al.* (19) in guava, Sharma and Singh (18) in date, Sandhu and Singh (15) in peaches and Abbas *et al.* (1) in orange. Declining trend was noted thereafter irrespective of the treatments. A much reduced T.S.S. was noted on nine days after storage. The initial increased rate of T.S.S. might be due to rapid loss of water from the fruits and the conversion of starch in to sugar at a faster rate (Pool *et al.*, 12). The decreased T.S.S. content at later stage of storage might be due to exhaustion of substrate of conversion i.e. starch (Leopold, 8).

Effect on Reducing sugars and Total sugars: The present investigation revealed that the total sugars and reducing sugar increased with increasing ethrel concentration (Table 2).The maximum total sugar (8.11%) and reducing sugar (6.36%) was observed in 1500 ppm treated fruits as early as three days after storage. The values of sugar content increased upto 6 days after storage and declined thereafter except in 1500 ppm treated fruits where the value decreased on 6 days after storage. In the present experiment, ethrel enhanced the rate of accumulation of reducing sugar in papaya fruits. Similarly, high percentage of reducing sugar with ethrel application in dates was observed by Sharma and Singh (18). The finding is corroborated with the result of Kumar and Singh (7) who observed that higher percentage of sugar in ethrel (750 and 500 ppm) treated mango fruits over control).

Effect on Ascorbic Acid : the ascorbic acid (Table 2) increased significantly up to 6 days after storage for all the treatment (except 1500 ppm) and declined thereafter but the maximum ascorbic acid was observed in 1500 ppm (44.44mg per 100g) as early as 3 days after storage. The fruits during storage, in general showed a declining trend in ascorbic acid content significantly irrespective of the treatments applied but the value was increased with corresponding increase in the concentration of ethrel. A reduction in ascorbic acid content with the subsequent prolongation of storage might be due to rapid oxidation phenomenon of organic acid in later storage of storage (Orzolek and Argel, 11).

Effect on Total Carotenoids : A significant increase in total carotenoids (Table 3) was observed upto six days after storage in all the treatment and declined thereafter except in 1500 ppm where decline in total carotenoids occurs on 6 days after storage. The maximum total carotenoids was observed in 6 DAS in 1000ppm (3.12 mg per 100g) while 2.88 mg per 100g of total carotenoids was observed in 1500ppm treated fruits an early as 3 days after storage.Ethylene might increase the carotenoid through its synthesis. This fact was established by Young and Jahn (21) while working in citrus.

Effect on the Organoleptic evaluation : Present investigation (Table 3) revealed that ethrel application had significantly influenced the sensory evaluation scores for flesh colour, flavour, texture, aroma and overall acceptability scores. In support

of the present study, the colour development in papaya fruits was remarkably affected by post-harvest application of ethrel. Out of all the concentrations of ethrel tried, 1500 ppm gave the most attractive and deep coloured fruits. The findings of Shanmugavelu *et al.* (17) in mango and papaya support the contention that ethrel treated fruits develop attractive colour. However, the specific mode of action of ethrel in accelerating colour development is not clearly understood. Nour and Goukh (10) observed that peel colour score progressively increased during ripening of guava fruits. They observed that fruits treated with ethrel (250-1000 ppm) reached the full yellow stage 3, 4 and 6 days earlier than untreated fruits respectively. They also reported ethrel treated fruits had reached the soft stage 2-6 days earlier than the control. The study was also supported by Jayawickrama *et al.* (6) observed that sensory evaluation scores recorded for flesh colour, aroma ,taste and overall acceptability were significantly higher in ethrel treated papaya fruits as compared to control.

CONCLUSION

It can be concluded from the present investigation that use of ethrel had a significant impact on the shelf life of the papaya fruits because the ethrel treated fruit could retain the characters like T.S.S., acidity, sugar, ascorbic acid, total carotenoids and organoleptic characters for a longer duration than control. Among the treatments ethrel application @1000 ppm was the best for retaining the various physical, chemical and sensory attributes followed by ethrel application @ 750 ppm till the end of storage studies whereas ethrel @ 1500 ppm was the best for inducing the earliness of ripening in fruits and preserving efficiently various physical, chemical and sensory attributes till 6 DAS.

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FRUIT YIELD AND QUALITY OF PEACH (*Prunus persica* Batsch.) AS INFLUENCED BY DIFFERENTIAL APPLICATION OF ZINC

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ABSTRACT: The data revealed that fruit yield of peach increased with increasing application of zinc sulphate. The maximum fruit size (5.0 cm length and 4.9 cm breadth), fruit weight (89.00g), fruit yield per plant (58.25 kg) and yield per unit area (64.07 q/hectare) were observed with 800 g $ZnSO_4$ per plant as soil application followed by foliar spray (0.5%) whereas minimum yield was obtained without zinc application. Zinc application also improved total soluble solids (TSS) and TSS: acid ratio. However, acidity of fruits obtained from treated and untreated plants was not differ significantly but the highest acid content was observed in control plants, whereas lowest was in foliar application of 0.50 % $ZnSO_4$. Fruits were also more palatable in Zinc applied plants. The highest concentration of zinc (11.55 ppm) in leaves was observed at higher doses of soil zinc application and was in lowest in control plants.

Keywords: *Peach, yield, quality, zinc concentration.*

Peach (Prunus persica) is one of the important temperate fruit grown in Punjab. This fruit crop is popular due to rich source of vitamin-A, iron and proteins. Peach is generally consumed as fresh as well as in the form of squash in the North Indian Plains. Its kernel oil is utilized in the manufacturing of cosmetics and pharmaceutical products. Gangwar *et al.* (6) surveyed the economy of peach cultivation in North Indian Plains and revealed that investment in peach orchards has been found a profitable business. The internal rate of return (IRR) has been found to vary from 20.98 per cent to 23.80 per cent, depending on the size of peach orchards.

Cultivation of stone fruits especially peach, plums and apricot has become popular in the subtropical climates of the North Indian Plains during past few years. The cultivation of this crop in Punjab has been expanded to many folds and occupies an area of about 1476 hectare producing about 25236 tones of fruit annually (Anonymous, 2). Few studies on peach nutrition in Punjab have been conducted and these were limited to N, P, and K application. Foliar fertilization is effective method for the application of micronutrients like zinc to established fruit trees. One of the most critical periods when a zinc shortage may seriously impair tree performance is between bud break and fruit set. A zinc shortage at this time often results in poor growth of the leaves and new shoots, as well as abnormal development of pollen tubes, ultimately resulting in poor seed set in fruit crops. Later in the season, the effects of limited zinc are small fruit, poor yield and quality of fruits. Zinc is not readily mobile within the tree and applications must be thorough and timely for optimal response. Various methods of applying zinc are available; the most common being sprays of zinc sulphate and soil applications of zinc sulphate. The present investigations were conducted to observe the effect of different doses of soil and foliar applied Zn on fruit yield and quality of peach fruits.

MATERIALS AND METHODS

The experiment was carried out to find out the effect of zinc fertilization on the yield and fruit quality of peach at Punjab Agricultural University, Regional Station Bathinda in the year of 2011. The soil of the experimental field was calcareous, non saline and alkaline nature having pH 8.70 and electrical conductivity 0.21 ds m^{-1}. The soil was low in organic carbon (0.21 per cent), medium in available phosphorus (18 kg ha^{-1}) and was high in available K (495 kg ha^{-1}). The content of DTPA extractable Zn was 0.78 mg kg^{-1}. The experiment

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was laid out on 7 years old peach plants. The zinc was applied through zinc sulphate at the rate of 200g, 400g and 800g per plant as soil and 0.50 % $ZnSO_4$ (neutralized with calcium hydroxide) as foliar application. The experiment was conducted in randomized block design (RBD) with four replications.

The basal doses of N, P and K were applied at the rate of 450g, 125g and 500 g per tree, through urea, single super phosphate and muriate of potash, respectively. The foliar spray of 0.50 % zinc sulphate was applied in the month of March. The crop was harvested in the end of April and data on fruit yield and quality were recorded.

The physico-chemical characteristics of fruits were recorded in the months of April-May. The observations on physical characters of fruits and yield were noted in terms of fruit size, fruit weight, yield per plant and yield per hectare. Similarly, the quality characters of fruits were recorded in terms of palatability rating, total soluble solids, acidity and TSS acid ratio. Palatability rating was given on the basis sensory quality and appearance of fruits by the panel of five judges. Total soluble solid was determined by using hand refrectometer and acidity was calculated as per methods of AOAC (1).

For the estimation of zinc in leaves, the samples were collected from the plants in the month of May. The collected leaves were washed with diluted HCL, distilled and finally with double distilled water. The samples were digested in acids mixture for the determination of zinc and analyzed by atomic absorption spectrophotometer. The TSS was estimated by hand refrectrometer and the acidity was estimated by titrating the juice against 0.1 N NaOH solution.

RESULTS AND DISCUSSION

Effect on size and yield of fruits: Fruit size was significantly affected with different applications of $ZnSO_4$. Maximum fruit size in terms of length and breadth (fruit length 5.0 and fruit breadth 4.9 cm) was highest in each T_4 and T_5 and smallest fruits were obtained from plants kept as control (Table 1). The fruit size was significantly smaller in treatments with lower doses of $ZnSO_4$. The results of the experiment also indicated that fruit yield improved with the increasing application of zinc to plants. The yield increased from 45.25 kg per plant to 58.25 kg per plant. Maximum fruit yield of peach was observed with the application of 800g zinc sulphate per plant, whereas the minimum yield (45.25 kg per plant) was recorded in control. The application of $ZnSO_4$ at concentration of 400 and 800g per plant significantly improved fruit yield over control. The effect of foliar application of $ZnSO_4$ at the rate of 0.50 per cent on fruit yield was found statistically at pat with $ZnSO_4$ @ 800 g per plant as soil application and better than treatment T_1 and T_2. The fruit yield per unit area was also highest in highest dose of soil applied $ZnSO_4$, however it was statistically at par with foliar applied $ZnSO_4$ to plants. The similar results were also recorded by Chatzitheodorou *et al.*, (5) who observed that application of Zn through manure improve the yield of peach. Zinc sulphate applied to the soil at the rate of 200 g per tree increased fruit yield markedly (Thomidis *et al.* 7). Similarly, fruit weight was also improved with $ZnSO_4$ application. The increment in fruit weight with increasing doses of $ZnSO_4$ was recorded. The fruits of T_4 and T_5 were heaviest and the weight of fruit in control plant was lowest. It is evident from the results that application of zinc is necessary for obtaining good yield. The increase in fruit size and yield may be due to increase in the rate of photosynthesis and activity of carbonic anhydrous with zinc application in peach plants (Basiouny and Baggs, 3). Tiwari *et al.* (8) also found similar results and observed that foliar application of zinc at the rate of 0.4-0.5 per cent have was effective on improving yield of peach fruit.

Effect on quality: The effect of zinc application on fruit quality (Table 2) showed that the total soluble solids content of the fruits increased significantly in all the zinc treated plants than untreated plants. The highest total soluble solids was recorded in T_4 (11.14 %) followed by T_5 (11.00 %) and lowest total soluble solids (10.08 %)

Table 1: Effect of zinc application on the physical characters and yield of peach fruits.

Treatments ($ZnSO_4$)	Fruit length (cm)	Fruit breadth (cm)	Fruit weight (g)	Fruit yield per plant (kg)	Fruit yield per hectare (q)
Control T_1	4.45	4.4	76.00	45.25	49.77
200 g (SA) T_2	4.50	4.6	79.25	49.25	54.17
400 g (SA) T_3	4.8	4.6	82.25	52.50	57.75
800 g (SA) T_4	5.0	4.9	89.00	58.25	64.07
0.5% (FA) T_5	5.0	4.9	88.00	58.00	63.80
CD (P = 0.05)	0.02	0.02	1.80	6.12	4.05

SA: Soil application, FA : Foliar application.

Table 2. Effect of zinc application on the chemical characters of peach fruits and leaf Zn content.

Treatments ($ZnSO_4$)	TSS %	Acidity %	TSS/Acidity ratio	Palatability rating	Leaf Zn concentration (ppm)
Control T_1	10.08	0.84	12.07	7.8	7.64
200 g (SA) T_2	10.46	0.78	13.42	7.7	10.23
400 g (SA) T_3	10.85	0.78	13.92	8.0	10.35
800 g (SA) T_4	11.14	0.73	15.26	8.1	11.55
0.5% (FA) T_5	11.00	0.75	14.66	8.2	9.70
CD (P = 0.05)	0.52	NS	1.72	0.20	1.17

SA: Soil application, FA : Foliar application.

was in control plant. Similarly TSS/Acidity ratio was also highest in T_4 treatment followed by T_5 and lowest ratio was observed in control. However, the acidity was found to be in decreasing order with the increasing levels of zinc sulphate application. The decrease was observed from 0.84 to 0.73 % from control to 800g Zn application but the effect of zinc on acidity was observed non significant. This shows that in addition to increase in yield of fruit, zinc application had favourable effect in improving the quality of fruit by increasing TSS and reducing acidity in this study. The results are in association with the results of Lal *et al.* (4) who reported that total soluble solids (TSS) in the fruit was significantly higher with the soil application of zinc sulphate (0.5 kg tree ^{1}) as compared with all other treatments of zinc sulphate and the control in mango plants.

Leaf Zn concentration : The data (Table 2) revealed that the concentration of zinc in plant leaves increased with the soil or foliar application of zinc. The concentration of zinc in plant significantly increased in T_2, T_3 and T_4 treatments but the effect among these treatment was found non significant. Maximum concentration (11.55 ppm) was observed in T_4 treatment where zinc was applied through soil application @ 800g per plant, however, minimum concentration (7.64 ppm) was observed in control. In the present investigation data reveals that soil application of zinc contribute in the higher zinc content in plants as compared to foliar application. This may be due to continuous absorption of zinc from soil and its translocation to plant parts whereas foliar application of zinc on plant did not reach the concentration at the level than soil application. Thomidis *et al.* (7) also reported that foliar application of zinc sulphate

solution increased the Zn content of leaves and no toxicity was observed when applied in the month of May. Contrastingly, foliar application of 6 % zinc sulphate and soil application of zinc sulphate at the rate of 200 g per tree did not affect the Zn content of leaves when applied in the month of February.

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EXTENDING HARVESTING PERIOD OF LITCHI (*Litchi chinensis* Sonn.) THROUGH CHEMICALS APPLICATION

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ABSTRACT: An experiment was conducted to stagger the harvesting of litchi in cultivar Rose Scented. In this regard, various kinds of treatments were imposed on 20 years old full bearing litchi tress either at flower initiation or few days before harvest of fruits. KNO_3 (4%) was sprayed at 1 cm size of panicle in the first week of February. However, other treatments viz. GA_3 (20, 40 ppm), BA (20, 40 ppm) and bagging of fruit panicles were applied two weeks before expected date of harvest, while silver thiosulphate (10 m mol) sprayed twice (on 30th April and 15th May). Shading treatments were given by covering the tree with nylon nets producing 30% and 50% shade, respectively, 30 days after fruit set. KNO_3 (4%) and cluster bagging treatments advanced the harvesting for 2 and 3 days, respectively over control. Shade nets of 30% and 50% were most effective in delaying ripening of litchi fruits and delayed the harvest date by 14 and 16 days, respectively without compromising with the fruit quality. Silver thiosulphate gave a harvest delay of 8 days, however, a few brown spots on fruit skin were observed after the spray. GA_3 20 and 40 ppm delayed the harvest date for 2 and 5 days, respectively while BA delayed the harvest date for 5-6 days. Higher fruit retention and reduced fruit cracking were obtained with shade net (50%) which was remained at par with shade net (30%) and cluster bagging. Higher fruit quality attributes were recorded with GA_3 (40 ppm) over other treatments.

Keywords: *KNO_3, GA_3, BA, shading, litchi, quality.*

Uttarakhand is one of the most popular states of the country known for its quality litchi production. The litchi industry in Uttarakhand is based on one major cultivar, the 'Rose Scented'. Its harvesting period is quite short, 7 to 10 days. The availability of fresh litchi fruits in the market may be extended for another few days by utilizing other genotypes available in the litchi. However, much scope is not there as available genotypes differ little with regard to their maturity period (Ray and Sharma, 9). Two pronged strategy may be employed to solve the problem i.e., either advancing the date of harvest or delaying the date of harvest.

Still, there is no commercial method to be used for either advancing or delaying the harvesting time of litchi and thus extending the harvesting and marketing season. The motive of this study was to test methods for extending harvesting period of litchi. An alternative approach to induce early flowering and fruiting by using KNO_3 has been successfully used in mango (Kumar *et al.,* 6). GA_3 has been found to offer suitable means of controlling ripening process in litchi (Ray and Sharma, 9) and in other fruit crops (Dilley, 3, and Lavon *et al.,* 7). Evidence suggest that cytokinins retards sugar accumulation and pigmentation in litchi fruits (Wang *et al.,* 13).Yin *et al.,* (14) demonstrated inhibition of litchi fruit maturation and colouration following silver thiosulphate (STS) spray, indicated that ethylene is involved in the regulation of ripening events. Bagging of fruits including litchi can improve ripening and reduce physical damage (Tyas *et al.,* 11 and Wang et. al, 13). Shading has been found to delay the fruit ripening in cactus pear (Mantia *et al.,* 8), however, little information is available on litchi (Zipori *et al.,* 15). The objective of this study was to determine the relationship between integrated use of various treatments and litchi fruit maturity, size and quality.

MATERIALS AND METHODS

The experiment was carried out in 2007 at HRC, Patharchatta, G.B.P.U.A&T., Pantnagar on 20 year old plants of litchi cv. Rose Scented, spaced

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10 10 m and maintained under uniform cultural practices. The experiment was laid out in a randomized block design with three replications. All the treatments were applied after fruit set except 4% KNO_3 (T_1), which was sprayed at 1 cm panicle stage in the month of February. First and second sprays of 10 m mol silver thiosulphate (T_2) were carried out on 30th April and 15th May respectively. GA_3 at 20 ppm (T_3) and 40 ppm (T_4) and BA (6-Benzyl adenine) at 20 ppm (T_5) and 40 ppm (T_6) were sprayed only once, on 15th May *i.e.* 2 week before from expected date of normal harvest. Teepol (2 ml/l) was added to the solution as wetting agent. Cluster bagging (T_7) with perforated and transparent polyethylene was also carried out 2 week before harvesting on 15th May. Shading treatments were gives on 1st May *i.e.* 30 days after fruit set. Trees were shaded by erecting over head shade nets producing 30% (T_8) and 50% (T_9) shade. Shade nets were removed one week before harvesting so that fruit colour of trees could be improved. There were total 10 treatments including control (T_{10}). All treatments were applied to separate trees.

Randomly 10 panicles were selected in each tree for recording data on fruit cracking and other fruit quality attributes. The fruits were considered to be ripe when they developed a bright pinkish-red blush with flattened tubercles (Gaur and Bajpai, 5). TSS was determined by using ERMA hand refractometer and acidity, regarded as citric acid, by titration of the juice with 0.1 N NaOH using phenolphthalein as the indicator. For estimating ascorbic acid, the fresh juice to which 4% metaphosphoric acid as stabilizing reagent had been added was titrated against 2:6 dichloro-indo-phenol dye solution. Reducing sugars were determined by titrating the juice with fehling's solutions A and B (standardized) using methylene blue as indicator. For determining total sugars, the juice was subjected to acid hydrolysis and total sugars were estimated by the method described for reducing sugars.

RESULTS AND DISCUSSION

In general, all the treatments except T_1 (4% KNO_3%) and T_7 (Cluster bagging) delayed ripening and thus extended the harvesting period in litchi cv. Rose Scented. However, treatments T_1 and T_7 advanced the harvest period by 2-3 days as compared to control (Wang *et al.,* 13). Shade nets (30% and 50%) *i.e.* T_8 and T_9 were the most effective treatments with regard to delay in harvest time, and delayed the date of harvesting by 14 and 16 days, respectively with significant reduction in fruit cracking and fruit weight was significantly higher over control (Table 1). Fruit quality in terms of TSS, acidity, ascorbic acid and total sugars were significantly higher over control. Zipori *et al.* (15) effectively delayed fruit ripening by 7 to 10 days with the help of plastic nets producing 30% and 50% shade without impairing fruit quality. Cladode shading resulted in a consistent delay of fruit ripening when the shade period exceeded 15 day. This might be due to the fact that exposure of fruits to solar radiations affects fruit sink activity (Erez and Flore, 4) and shading the fruit environment reduces fruit development processes (Byers *et al.*, 2). Application of silver thiosulphate (STS) at 10 m mol delayed harvesting by 8 days without any appreciable alteration in fruit weight and other chemical quality attributes. However, brown spots on fruits skin were appeared which might be due to higher concentration of silver ions; therefore, its lower concentration may be tried for better result. Phyto-toxicity has also been also reported by Beyer (1). Wang *et al.* (13) demonstrated possible role of ethylene in chlorophyll degradation in litchi, action of which might have been inhibited by silver thiosulphate (Yin *et al.,* 14). Spray of GA_3 at 40 ppm delayed harvesting by 5 days as compared to control with reduced fruit cracking, as well as acidity and with improved fruit and aril weight, TSS, ascorbic acid and total sugars. Increase in fruit and aril weight with enhanced fruit quality attributes and harvest delay in litchi with exogenous application of GA_3 has been reported earlier by Thakur *et al.* (10) in litchi.

Table 1: Effect of chemical treatments on harvest advancement/delay and fruit quality of litchi cv. Rose Scented.

Treatment	Days taken to maturity	Harvest**		Fruit cracking (%)	Fruit weight (g)	Pulp weight (g)	TSS (°Brix)	Acidity (%)	Ascorbic acid (mg/100 g)	Total sugar (%)
		Advancement	Delay (day)							
T_1 (4% KNO_3)	58.33	2.33	-	10.77	22.20	16.20	20.52	0.52	27.99	13.43
T_2 (STS)*	68.66	-	8.00	9.21	21.29	15.65	20.75	0.67	27.98	13.50
T_3 (GA_3 20 ppm)	63.00	-	2.34	7.43	22.25	16.32	21.00	0.63	28.56	13.58
T_4 (GA_3 40 ppm)	65.66	-	5.00	6.13	22.30	16.38	22.15	0.56	28.83	14.25
T_5 (BA 20 ppm)	66.00	-	5.34	7.99	22.31	16.41	21.75	0.61	28.53	13.02
T_6 (BA 40 ppm)	67.00	-	6.34	7.93	22.24	16.38	21.40	0.66	28.92	13.20
T_7 (Bagging)	57.33	3.33	-	8.33	20.99	15.68	20.66	0.69	28.18	13.08
T_8 (30% shade net)	74.66	-	14.00	5.28	21.59	16.20	20.65	0.69	28.16	13.12
T_9 (50% shade net)	77.00	-	16.34	4.49	21.59	16.30	20.71	0.70	32.70	13.13
T_{10} (Control)	60.66	-	-	12.71	19.06	13.56	18.63	0.73	25.84	12.52
C.D. (P = 0.05)	1.84			3.85	1.03	0.86	1.26	0.045	4.70	0.34

*Silver thiosulphate.
** Harvest advancement/delay was counted by considering the date of harvest of control plants.

The harvest delay resulting from BA at 40 ppm was 6 day which is comparable to that gained with silver thiosulphate (STS) at 10 m mol; however, STS at this concentration had resulted in brown spotting of the fruits with less aril weight as well. Fruit quality of BA treated fruits was found to be at par with GA_3 treated fruits. Delayed maturity with 6-Benzyl adenine (BA) as observed during present investigation corroborated the earlier finding of Wang *et al.* (12). Cytokinin either inhibit or delay the colour changes in litchi fruit green to red associated with ripening though without influencing other changes markedly also supports the earlier finding of Wang *et al.* (13).

Shading as well as other treatments profoundly affect on the ripening process of litchi cv. Rose Scented. Thus, they provide an opportunity for litchi growers to stagger the date of harvest as per the market demand.

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INTERACTION EFFECT OF CHEMICAL AND BIO-FERTILIZERS ON GROWTH AND YIELD OF ONION (*Allium cepa* L.)

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ABSTRACT : The present investigation comprising the supplementation of chemical and biofertilizers for onion crop was carried out under field conditions at Horticultural Research Farm of Babasaheb Bhimrao Ambedkar University, Lucknow during *rabi* season of 2010-2011. The experiment comprised of four levels of chemical fertilizers and six levels of biofertilizers. The maximum plant heights, number of leaves, neck thickness, bulb diameter, bulb weight, number of scales and yield were found with the application of T_{12} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM) that was closely followed by T_{11} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha Phosphobacteria), T_{18} (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM) and T_{17} (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha Azotobacter + 2 kg/ha Phosphobacteria) respectively. Minimum number of days required for bulb formation and number of days taken to maturity were also obtained with the application of T_{12} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM). Results obtained by the application of inorganic fertilizers with biofertilizers exhibited significant effect on various parameters studied under the investigation.

Keywords : *Chemical fertilizer, biofertilizer, Azotobacter, VAM, onion, growth, yield.*

Onion (*Allium cepa* L.), is bulbous biennial herb of family Alliaceae is one of the most important vegetable cum condiment crops demanded worldwide. Moreover, onion is the only vegetable in which India figures prominently in the world for production and export (Singh and Joshi, 12). Onion is an immense potential crop being part of medicinal values and hence, useful in fever, dropsy, catarrh and chronic bronchitis. Raw onion has an antiseptic value through the alimentary canal. It promotes bile production and reduces blood sugar. It is rich in minerals like phosphorus and calcium, vitamin C, protein and carbohydrates. In order to meet the increasing demand of the consumers and fill the gap in off-season, onion is now gaining popularity as *kharif* season crop too. Crop production of onion is affected by several factors. Usually little or no chemical fertilizer is added to this crop and hence characterized by low yield. Therefore, there is a need to study the possible ways of improving the yields of this crop. Biofertilizer have recently gained with momentum for affecting the sustainable increase in crop yield under various agro climatic conditions. Biofertilizers are live carrier based microbial preparations used in agriculture as low input resources to enhance the availability of plant nutrients or promote the growth by way of synthesizing growth factors. Role of biofertilizer on the crop growth and yield was documented by Vijayakumar *et al.* (13) and Ramakrishnan and Thamizhiniyan (8). *Azotobacter* fixes atmospheric nitrogen independently near the root zone thus, enhancing the available nitrogen to the soil whereas phosphobacteria solublize the soil phosphorus and makes them easily available for the plants. Vesicular-Arbuscular Mycorrhizae (VAM) play a vital role in development of stronger root system, improved growth (Zandavalli *et al.,* 14), nutrient uptake, increase tolerance of host roots to soil borne pathogens (Nelson and Achar, 6).

Uses of biofertilizers in onion production, to at least partially supplement its nutrient demand and to improve soil fertility by way of the integration of different sources of plant nutrients in desired. Onion has a good response for biofertilizer inoculation due to real nature of their root

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morphology. Literature indicates the very little information, therefore, keeping in view the above facts, present research work was undertaken on growth, yield and yield attributing characters of onion applying various biofertilizers and graded level of chemical fertilizers.

MATERIALS AND METHODS

The present investigation was carried out at the Horticultural Research Farm of the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, Lucknow during the rabi season of 2010-2011. The experiment comprised of four levels of inorganic fertilizers-1. $N_0P_0K_0$ (Without inorganic fertilizers) C_0, 2. $N_1P_1K_1$ (100 kg N + 50 kg P + 70 kg K/ha) C_1, 3. $N_2P_2K_2$ (75 kg N +37.5 kg P + 52.5 kg K/ha) C_2, 4. $N_3P_3K_3$ (50 kg + 25 kg P + 35 kg K/ha) C_3; and six levels of biofertilizers-1. Uninoculated (Without biofertilizers) B_0, 2. *Azotobacter* (2 kg /ha) B_1, 3. Phosphobacteria (PSB) (2 kg/ha) B_2, 4. Vesicular-Arbuscular Mycorrhizae (VAM) (1900 kg/ha) B_3, 5. *Azotobacter* (2 kg/ha) + Phosphobacteria (2 kg/ha) B_4, and 6. *Azotobacter* (2 kg/ha) + VAM (1900 kg/ha) B_5.

Thus, having a total of 24 (4x6) treatment combinations, *i.e*. T_1 (C_0B_0), T_2 (C_0B_1), T_3 (C_0B_2), T_4 (C_0B_3), T_5 (C_0B_4), T_6 (C_0B_5), T_7 (C_1B_0), T_8 (C_1B_1), T_9 (C_1B_2), T_{10} (C_1B_3), T_{11} (C_1B_4), T_{12} (C_1B_5), T_{13} (C_2B_0), T_{14} (C_2B_1), T_{15} (C_2B_2), T_{16} (C2B3), T_{17} (C_2B_4), T_{18} (C_2B_5), T_{19} (C_3B_0), T_{20} (C_3B_1), T_{21} (C_3B_2), T_{22} (C_3B_3), T_{23} (C_3B_4) and T_{24} (C_3B_5). The quantity of fertilizers was given as per treatment. The entire amount of phosphorus and potassium along with half dose of nitrogen were applied as basal dose during the field preparation and rest amount of nitrogen was applied as top dressing in two- equal split doses at 30 and 60 days after transplanting. *Azotobacter,* Phosphobacteria and Vesicular-Arbuscular Mycorrhizae were applied at the time of transplanting *i.e. Azotobacter* and PSB as seedling root treatment and VAM as soil application. The transplanting was done in the last week of December 2010 and the seedlings were transplanted in the evening at 10 x 15 cm spacing. The experiment was laid out in R.B.D with twenty four treatments and replicated thrice. All the standard package of practices and plant protection measures were timely adopted to raise the crop successfully. Five randomly selected plants from each replication were utilized for recording observations on plant height (cm), number of leaves/ plant, number of days required for bulb formation, number of days taken to bulb maturity, neck thickness, bulb diameter, bulb weight, number of scales per bulb and yield (q/ha). Statistical analysis of the data was done as per standard method.

RESULTS AND DISCUSSION

Growth parameters

The observations recorded on plant height, number of leaves per plant, number of days required for bulb formation and number of days taken to maturity was significantly influenced by the interaction of inorganic fertilizers and biofertilizers. Perusal of Table 1 clearly indicates that the maximum plant heights and number of leaves (30.60 cm, 41.13 cm and 58.06 cm and 4.00, 5.86 and 8.00, respectively) were recorded at 30, 60 and 90 days after transplanting with the application of T_{12} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM) which remained at par with treatment T_{11} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha Phosphobacteria) and T_{18} (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM).Whereas, the minimum plant heights and number of leaves were recorded 20.20 cm, 28.60 cm and 40.53 cm and 2.33, 4.00 and 5.26, respectively at 30, 60 and 90 days after transplanting under control. These results are in confirmation with the findings of Jayathilake *et al*. (3) and Plenchette *et al.* (7). Singh *et al.* (11) also reported increased plant height and leaf number of onion with the use of VAM. Minimum number of days required for bulb formation (67.06) and number of days taken to maturity (129.86) were obtained with the application of T_{12} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 1.9

Table 1: Interaction effect of chemical and bio-fertilizers on growth and yield of onion (*Allium cepa* L.) under Lucknow conditions.

Treatments	Plant height (cm)			Number of leaves/ plant			Number of days required for bulb formation	Number of days taken to bulb maturity	Neck thickness (cm)	Bulb diameter (cm)	Bulb weight (g)	Number of scales per bulb	Yield (q/ha)
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT							
T_1	20.20	28.60	40.53	2.33	4.00	5.27	79.20	140.00	0.81	4.13	78.20	5.80	169.78
T_2	21.13	30.13	43.07	2.53	4.20	5.47	77.60	138.07	0.86	4.50	91.33	6.33	174.44
T_3	19.87	29.53	42.20	2.63	4.20	5.47	78.07	138.07	0.85	4.27	87.60	6.27	172.11
T_4	20.93	30.57	44.20	2.60	4.27	5.87	77.80	138.20	0.90	4.77	96.87	6.60	204.44
T_5	21.67	31.07	44.47	2.63	4.47	6.00	76.80	137.47	0.95	4.80	101.00	6.87	223.55
T_6	22.20	31.47	45.77	3.00	4.53	6.07	72.00	136.40	0.96	5.00	107.07	7.00	253.89
T_7	24.60	36.20	54.60	3.20	4.47	6.33	71.07	134.07	1.27	5.93	135.33	7.20	322.22
T_8	26.67	35.60	55.33	3.20	4.80	6.40	71.87	132.00	1.35	6.20	141.33	8.27	342.22
T_9	27.07	37.33	54.07	3.47	5.00	7.00	71.93	133.67	1.42	7.00	147.33	9.00	365.44
T_{10}	27.20	37.00	54.07	3.40	5.13	7.20	71.00	132.00	1.45	7.20	150.27	9.00	368.88
T_{11}	29.07	39.13	57.67	3.53	5.50	7.73	69.07	130.00	1.48	7.53	174.80	9.87	397.78
T_{12}	30.60	41.13	58.07	4.00	5.87	8.00	67.07	129.87	1.51	8.07	180.27	10.33	417.77
T_{13}	27.07	37.87	50.67	3.00	4.67	6.20	72.93	134.20	1.30	6.13	131.33	8.20	308.88
T_{14}	25.80	36.07	52.27	3.07	4.67	6.53	72.67	134.00	1.30	6.20	138.67	8.27	333.33
T_{15}	25.67	35.67	49.07	3.13	4.73	6.80	72.73	134.07	1.32	6.33	138.67	8.33	340.00
T_{16}	26.03	36.07	51.20	3.47	4.80	7.27	72.67	134.67	1.32	6.27	140.80	8.20	338.33
T_{17}	27.73	38.27	55.40	3.60	5.00	7.47	70.67	131.60	1.48	7.00	150.67	9.00	368.22
T_{18}	27.93	39.47	56.13	3.67	5.33	6.27	70.53	130.40	1.50	7.33	159.33	9.73	380.22
T_{19}	26.00	32.07	46.07	2.73	4.93	6.27	76.40	135.53	1.17	5.33	132.00	7.27	244.66
T_{20}	25.30	35.27	51.20	2.77	4.60	6.20	75.60	134.60	1.17	5.80	130.67	7.47	270.00
T_{21}	25.13	36.13	50.67	2.87	4.47	6.27	75.47	134.80	1.19	5.93	132.00	7.27	286.66
T_{22}	25.67	34.00	48.47	2.87	4.53	6.47	74.33	135.00	1.23	6.00	132.67	7.67	288.11
T_{23}	25.27	35.00	48.27	2.93	4.73	6.53	74.00	133.60	1.30	6.40	138.00	8.07	316.66
T_{24}	25.93	35.13	51.00	3.07	4.87	6.60	73.00	133.80	1.39	6.67	140.67	8.53	326.66
C.D. (P=0.05)	1.69	0.57	0.40	0.18	0.23	0.22	0.57	23.39	0.04	0.22	2.98	0.32	16.29

kg/ha VAM) that was closely followed by T_{11} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha Phosphobacteria) and T18 (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM), respectively. Whereas, maximum number of days required for bulb formation (79.20) and number of days taken to maturity (140.00) were obtained under control. The observation is in the agreement with report of Ranjan *et al.* (9).

Yield and yield attributing characters

The results indicated that the yield and yield attributing characters viz., neck thickness, bulb diameter, bulb weight and number of scales were significantly increased by inorganic and biofertilizers. It was also further observed (Table 1) that the maximum neck thickness (1.51 cm), bulb diameter (8.06 cm), bulb weight (180.26 g) and number of scales (10.33) were found with the application of T_{12} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM) that was closely followed by T11 (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha Phosphobacteria), T18 (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM) and T_{17} (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha Phosphobacteria), respectively. Whereas, the minimum neck thickness (0.80 cm), bulb diameter (4.13 cm), bulb weight (78.20 g) and number of scales (5.8) were obtained under control. The hyphae of mycorrhizal fungi often penetrate 7 cm or more beyond the root into the rhizosphere and may be absorbing water and nutrients from soil solution of different osmotic potential than the root surface Rodes and Gerdemann (10). The improved water relations of mycorrhizal plants, although attributed to 'P' nutrition, could further benefit the water balance of plants. Biofertilizers along with chemical fertilizers resulted in substantial increase in bulb yield. Maximum yield (417.77 q/ha) was seen under T_{12} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM) that was closely followed by T_{11} (100 kg N + 50 kg P + 70 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha Phosphobacteria), T_{18} (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha *Azotobacter* + 1.9 kg/ha VAM) and T_{17} (75 kg N +37.5 kg P + 52.5 kg K/ha + 2 kg/ha *Azotobacter* + 2 kg/ha Phosphobacteria), respectively. Thus, the yield maximization through VAM inoculation (Andrea *et al.,* 1) could be achieved at VAM + ½ P + K against sole full dose of NPK. Similar results were also corroborates by Gurubatham *et al.* (2), Jayathilake *et al.* (4) and Mosse (5).

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INTEGRATED NUTRIENT MANAGEMENT IN GARDEN PEA (*Pisum sativum var. hortense*)

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ABSTRACT: An experiment was conducted to find out the effect of integrated nutrient management in garden pea (*Pisum sativum var. hortense*). The results indicated that application of vermicompost @ 1 t ha^{-1} + rest PK (50:25 kg ha^{-1}) through chemical fertilizers with variety Azad Pea-3 resulted maximum height of plant (59.40 cm), number of pods $plant^{-1}$ (8.46), weight of pods $plant^{-1}$ (41.22g), shelling percentage (50.66%) and yield of green pod (126.54 qha^{-1}). On the basis of cost of cultivation, maximum net return of Rs. 44392/ ha and C.B. ratio (1:2.93) was recorded under Azad Pea-3 with the application of vermicompost @ 1 t ha^{-1} + rest PK (50:25 kg ha^{-1}) and next best treatment was FYM @ 3 t ha^{-1} + rest PK (48:10 kg ha^{-1}) in the same variety which gave Rs. 41796/ ha with C:B ratio 1:2.57.

Keywords : *Garden pea, INM, vermicompost, shelling per cent, C:B ratio.*

Garden pea is one of the popular vegetable and it is also largely cultivated throughout the world for fresh and processed forms. India is the highest vegetable pea producing country in the world. It occupies 3.03 lakh hectare area with annual production around 20.38 lakh metric tonnes (NHB, 3). The share of peas was 2.3 % in total production of vegetables in 2001-02 (Rai and Panday, 5). In India, Uttar Pradesh is major pea growing state and it alone produces 61.75% more than half of total production of pea. Besides this, Madhya Pradesh, Bihar, Punjab, Haryana and Rajasthan are also major pea producing states (Subrahmanyam and Gaganana, 6). In India, pea is commercially grown for its green pods in *Rabi* season in the plains of Northern India. While in hilly areas, it is successfully grown during summer season. Research on effect of Integrated Nutrient Management in garden pea (*Pisum sativum* var. *hortense*) is meager in U.P. and particularly at Faizabad conditions. The present investigation was, therefore, carried out to see the effect of integrated nutrient management on height of plant, yield attributes, yield and economics of garden pea.

MATERIALS AND METHODS

The present experiment "Integrated Nutrient Management in Garden Pea (*Pisum sativum* var. *hortense*)" was conducted during *Rabi* season 2007-08 at Main Experimental Station, Department of Vegetable Science, Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.). The treatments comprised of three varieties of pea i.e. Arkel (V_1), Azad Pea-3 (V_2), NDVP – 6 (V_3) and twenty four treatment combinations with the various INM treatments i.e. F_1: Control, F_2: Recommended dose of NPK (30:60:40 kg/ha) through chemical fertilizers, F_3: FYM @ 3 t/ha + rest PK (48:10 kg/ha) through chemical fertilizers, F_4: Vermicompost @ 1 t/ha + rest PK (50:25 kg/ha) through chemical fertilizers, F_5: Neem cake @ 5.89 q/ha + rest PK (54:32kg/ha) through chemical fertilizers, F_6: FYM @ 1.5 t/ha + rest NPK (15:54:25 kg/ha) through chemical fertilizers, F_7: Vermicompost @ 0.5t/ha + rest NPK (15:55:32 kg/ha) through chemical fertilizers and F_8: Neem cake @ 2.9 q/ha + rest NPK (15:57:36 kg/ha) through chemical fertilizers. The experiment was laid out in RBD (Factorial) with three replications. Recommended dose of nitrogen (30 kg) was maintained with the use of 3t FYM, 1t Vermicompost and 5.8q Neem cake/ha and additional P & K that was provided through inorganic sources. Half of recommended dose of

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nitrogen (15 kg/ha) was provided through organic sources and rest of NPK was by the inorganic fertilizers. The crop was sown in the 1st November, 2007. Recommended cultural practices were timely adopted during the course of this investigation. The observations were recorded on growth, yield attributes and yield of garden pea affected by various treatments applied. The major nutrients (N, P, K) available in organic sources *i.e.* FYM, Vermicompost and Neem cake contained 1, 3 and 5.2 per cent N, 0.4, 1.0 and 1 per cent P_2O_5 and 1, 1.5 and 0.45 per cent K_2O, respectively. An economics of the treatments used in garden pea crop was calculated to draw suitable treatment of integrated nutrient management for higher production. The economics of the treatments were computed on the basis of prevailing market rates of produce and agro inputs.

RESULTS AND DISCUSSION

Variety and INM treatments showed significant response on yield attributes. The maximum length of pod (7.68 cm), number of pods/plant (7.42), average weight of pod (4.40 g) and pod yield (98.64 q) were obtained under variety Azad Pea-3 (V_2) which was significantly higher in comparison to variety Arkel (V_1). Among the various INM treatments, all the yield attributing parameters of garden pea such as number of grains/pod (7.33), number of pods/plant(7.67), weight of pods/plant (35.68 g) and shelling (48.33%) were significantly improved with the application of Vermicompost 1 t/ha + PK (50:25 kg/ha) as compared to recommended dose of NPK (30:60:40 kg/ha) and control followed by neem cake @ 5.8 q/ha + rest PK (54:32 kg/ha) and FYM @ 3 t/ha + rest PK (48:10 kg/ha), (Table 1). The increase in yield attributing parameters might be due to integration of organic manure with inorganic fertilizer increased the availability of nutrients and these nutrients being important constituents of nucleotides, protein, chlorophyll and enzyme involved in various metabolic processes which have direct impact on vegetative and reproductive phases of plant. Inorganic fertilizer and organic manures (Neem cake, FYM, Vermicompost, *Azospirillium* and *Phosphobacterium*) alone or in combination on growth yield and quality of tomato was tested by Kumaran *et al.* (1) and observed that the better response was observed when organic manures + inorganic fertilizers applied.

The data pertaining to yield of pods (q/ha) of garden pea varieties were markedly influenced by various treatments of organic manures and inorganic fertilizers (Table 2). Among the all treatment combinations, Vermicompost @ 1 t/ha + rest PK (50:25 kg/ha through chemical fertilizers) with variety Azad Pea-3 (V_2F_4) gave highest yield of pods (126.54q/ha) whereas, minimum yield was recorded under control plot (F_1) with variety Arkel. In this treatment, the higher values of yield attributing parameters like number of pods/plant, length of pod and weight of pods/plant were recorded and all the above parameters are directly associated for the enhancement of yield of pods (q/ha). This increase in the yield might be due to the use of vermicompost which is rich in major nutrients and in addition to that it contains micronutrients also. These nutrients are easily available to the development of plant and available nutrients retention capacity prolonged in the soil with application of vermicompost and its balance availability might be resulted in producing better yield with the integration of inorganic fertilizers. The above finding was supported by Patil *et al*. (4) who reported that among the other sources of organic manure, vermicompost @ 1 t/ha in addition with NPK improved the yield of tomato. Meena *et al.* (2) also reported that yield of pods was maximum with the application of vermicompost in comparison to FYM with recommended dose of nitrogen in garden pea.

The yield of pea varieties and economics of crop was affected by different INM treatments (Table 2). Among the treatment combinations, maximum yield of pods (126.54 q/ha), net return (Rs. 66,022) and cost benefit ratio (1 : 2.93) was recorded under the variety Azad Pea-3 with the application of vermicompost @ 1 t/ha + rest PK

Table 1: Effect of Varieties and INM treatments on yield attributes and green pod yield of garden pea.

Treatments	Height of plant (cm)	Length of pod (cm)	No. of grains pod^{-1}	No. of pods plant^{-1}	Average weight of pod plant^{-1} (g)	Weight of pod plant^{-1} (g)	Shelling percentage	Green pod yield (q/ha)
V_1-Arkel	53.38	7.27	6.62	6.37	4.16	27.30	45.00	81.50
V_2-Azad pea-3	56.51	7.68	6.95	7.42	4.40	32.50	47.08	98.64
V_3-NDVP6	54.75	7.38	6.67	6.67	4.19	28.58	45.58	84.83
C.D. (P = 0.05)	2.18	0.30	0.27	0.28	0.17	1.14	1.62	4.30
INM treatments								
F_1-Control	47.83	5.44	4.47	4.20	3.44	13.36	40.22	33.56
F_2-Reco. NPK (30:60:40 kg/ha)	53.07	7.50	6.84	6.72	4.09	27.59	47.67	82.87
F_3-FYM 3 t/ha + rest PK (48:10 kg/ha)	56.03	7.66	7.06	7.24	4.42	32.05	46.00	96.99
F_4-VC 1 t/ha + PK (50:25 kg/ha)	57.33	7.78	7.33	7.67	4.64	35.68	48.33	108.54
F_5-NC 5.89 q/ha + PK (54:32 kg/ha)	57.03	7.97	7.23	7.43	4.49	33.36	46.89	100.83
F_6- FYM 1.5 t/ha + NPK (15:54:25 kg/ha)	55.90	7.85	6.93	7.01	4.40	30.86	47.22	92.75
F_7-VC 0.5 t/ha + NPK (15:55:32 kg/ha)	55.00	7.67	7.04	7.12	4.38	31.18	47.44	95.26
F_8-NC 2.9 q/ha + NPK (15:57:36 kg/ha)	56.87	7.69	7.05	7.14	4.42	31.58	47.22	95.79
C.D. (P=0.05)	3.06	0.49	0.45	0.46	0.27	1.86	2.65	7.02

Table 2: Effect of INM treatments on economics of garden pea crop.

Treatments	Yield of pods (q/ha)	Gross income (Rs/ha)	Cost of cultivation (Rs /ha)	Net return (Rs/ ha)	Cost-Benefit ratio (C:B)
V_1F_1	34.62	24234	18195	6038	1: 0.33
V_1F_2	77.51	54257	20242	34014	1: 1.68
V_1F_3	89. 56	62692	20895	41796	1: 2.00
V_1F_4	95.64	66948	22555	44392	1: 1.97
V_1F_5	92.20	64540	24341	40198	1: 1.65
V_1F_6	86.86	60802	20569	40232	1: 1.96
V_1F_7	90.68	63476	21395	42080	1: 1.97
V_1F_8	84.93	59451	22229	37221	1: 1.67
V_2F_1	35.84	25088	18195	6038	1: 0.38
V_2F_2	95.54	66878	20242	34014	1: 2.30
V_2F_3	106.61	74627	20895	41796	1: 2.57
V_2F_4	126.54	88578	22555	44392	1: 2.93
V_2F_5	112.29	78603	24341	40198	1: 2.23
V_2F_6	99.98	69986	20569	40232	1: 2.40
V_2F_7	105.19	73633	21395	42080	1: 2.44
V_2F_8	107.14	74998	22229	37221	1: 2.37
V_3F_1	30.22	21154	18195	6038	1: 0.16
V_3F_2	75.56	54892	20242	34014	1: 1.17
V_3F_3	94.79	66353	20895	41796	1: 2.18
V_3F_4	103.43	72401	22555	44392	1: 2.21
V_3F_5	97.99	68593	24341	40198	1: 1.82
V_3F_6	91.41	63987	20569	40232	1: 2.11
V_3F_7	89.91	62937	21395	42080	1: 1.94
V_3F_8	95.31	66717	22229	37221	1: 2.00

* Sale rate of green pods @ Rs. 700 / q

(50:25 kg/ha through chemical fertilizers) and this treatment combination was found to be the most economical followed by FYM @ 3 t/ha + rest PK (48:10 kg/ha) in the same variety which gave 1:2.57 cost : benefit ratio. Hence, it is suggested that vermicompost @ 1 t/ha + rest PK (50:25 kg/ha though chemical fertilizers) will be useful for the cultivation of garden pea variety Azad Pea-3 under agro-climatic conditions of Eastern Uttar Pradesh, particular under Faizabad conditions.

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GENETIC VARIABILITY, HERITABILITY AND CORRELATION STUDIES IN CHILLI (*Capsicum annuum* L.)

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ABSTRACT: Genetic variability, heritability, genetic advance and correlation for different yield contributing characters were studied in 20 genotypes of chilli. Significant differences were observed among the genotypes for all the traits. The phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) for all the traits. Traits like number of branches at 150 DAT, days to flower anthesis, number of fruits per plant, average fruit weight, ascorbic acid, capsaicin content and fruit length showed positive correlation with fruit yield per plant (g). While leaf curl incidence showed negative correlation at genotypic level. Genetic advance at 5% was found high for plant height after 150 DAT, number of fruits per plant, ascorbic acid and fruit yield per plant (g). Whereas, genetic advance as per cent of mean at 5% was noticed high for all the traits except days to flower initiation and days to first harvest. Number of fruits per plant exhibited the highest positive direct effect followed by days to flower anthesis, plant spread (N-S) at 150 DAT, ascorbic acid content, plant height at 150 DAT and fruit length at genotypic level. In view at the direct and indirect contributions of component traits towards fruit yield per plant, selection on the basis of horticultural traits viz., average fruit weight and number of fruits per plant would be a paying preposition in the genotypes included in the study.

Keywords: *Chilli, GCV, PCV, heritability, correlation, path analysis.*

Chilli, widely known as pepper, is a member of family Solanaceae and is very important crop for vegetable and spice purpose. Chillies are one of the rich source of vitamin A (292 IU) and C (111 mg) per 100 g fresh weight available. There is a good scope for increasing its export by pushing up production. In India especially, it is considered as a mint master for adding foreign exchange to the states have given it a good locus in the area of Horticultural crops and hence the breeder work for overall improvement of this crop for profitable returns. A wide range of variability in chilli is available which provide a great scope for improving fruit yield through a systematic and planned selection programme. The present investigation was conducted for selected 20 genotypes to determine the extent of genetic variability, genetic coefficient, heritability, genetic advance and correlation of different characters in chillies.

MATERIALS AND METHODS

The field experiment was carried at the Vegetable Research Farm, Department of Horticulture, SHIATS, Allahabad. Seedlings of 20 genotypes of chilli were transplanted in a randomized block design with three replications during 2011-12. Seedling were transplanted in to the main field at 60cm row to row and 45cm between plant to plant spacing. All the recomended agronomic package of practices were followed. Observations on five randomly selected plants of each plot of each genotype were recorded for 14 quantitative characters viz. plant height, number of branches per plant, plant spread (N-S) and (E-W), days to flower anthesis, days to first harvest, number of fruits per plant, average fruit weight, capsaicin content, ascorbic acid content, fruit length, fruit diameter, leaf curl incidence and fruit yield per plant (g). The phenotypic and genotypic coefficient of variability were calculated according to the method suggested by Burton and DeVane (4). Heritability (broad sence), genetic advance and correlation were calculated according to the methods suggested by Hanson *et al.* (6), Johnson *et al.* (8), and Al-Jibouri *et al.* (2).

RESULTS AND DISCUSSION

Analysis of variance revealed significant differences among the genotypes for all the traits

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indicating the presence of sufficient genetic variability in the genotypes and considerable scope for their improvement. Sufficient genetic variability for many of the horticultural traits studied in chilli had also been reported by earlier workers (Acharya *et al.,* 1; Vani *et al.,* 13; Ukkund *et al.,* 14). The extent of variability with respect to 14 characters in different genotypes measured in terms of range, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), along with the amount of heritability (h), expected genetic advance and genetic advance as per cent of mean (GAM) are given in Table 1. The considerable amount of variation was observed for all the characters. The phenotypic coefficient of variability (PCV) was higher than the genotypic coefficient of variability in all the characters (Table 1). The estimates of PCV and GCV were high for fruit yield per plant, number of fruits per plant, capsaicin content and average fruit weight, moderate for days to first harvest and low for ascorbic acid content. Mishra *et al.* (11) also reported high phenotypic and genotypic coefficient of variations for fruit yield per plant, number of fruits per plant and fruit length, respectively. The heritability of the highest magnitude was noticed for fruit yield per plant (99.60) and moderate for leaf curl incidence (33.00). Thus, it indicated that larger proportion of phenotypic variance has been attributed to genotypc variance and reliable slection could be made for almost all the traits on the basis of phenotypic expression. High heritability estimates for fruit yield per plant, average fruit weight (Das and Choudhary, 5), number of fruits per plant (Sreelathakumary and Rajamony, 12), fruit length (Bhardwaj *et al.* 3), plant height (Ibrahim *et al.* 7) observed are in consonance with the present study. The heritability and high estimates of genetic advance (as per cent of mean) were observed in case of fruits yield plant (99.60 and 88.98), capsaicin content (99.10 and 81.43), number of fruits per plant (98.00 and 85.43). High heritability and high genetic advance have also been obtained by Bhardwaj *et al.* (3) for fruit yield per plant, Sreelathakumary and Rajamony (12) for average fruit weight, (Kataria *et al.* (9) and Sreelathakumary and Rajamony (12) for number of fruits per plant. High heritability along with with moderate to low genetic advance was observed for average fruit weight, days to first harvest, days to flower anthesis, number of branches, fruit length and fruit diameter. The results are in consonance with the findings of Ibrahim *et al.* (7) for fruit length and Manna and Paul (10) for fruit weight.

In the present experiment, the study of correlation among different characters revealed that, in general the genotypic correlation coefficient was larger than the phenotypic correlation (Table 2). This indicates little role of environment in the

Table 1: Range, mean, coefficient of variations, heritability and genetic advance of mean for 14 traits in chilli.

Sl. No.	Characters	Range		Mean	GCV %	PCV %	h^2(bs)	GA	GAM
		Min.	Max.						
1.	Plant height (cm) after 150 DAT	34.96	81.26	47.81	21.08	21.17	99.10	20.67	43.23
2.	No. of branches after 150 DAT	27.56	48.68	37.01	15.64	16.83	86.40	11.13	29.93
3.	Plant spread (E-W) 150 DAT	35.17	61.07	41.96	15.32	15.81	93.90	12.83	30.58
4.	Plant spread (N-S) 150 DAT	31.84	53.99	40.16	12.85	13.77	87.00	9.91	24.69
5.	Days to flower anthesis	26.73	36.80	32.27	9.73	11.23	75.10	5.61	17.38
6.	Days to first harvest	55.10	76.94	64.72	10.12	11.64	75.60	11.74	18.13
7.	Fruits per plant	12.84	203.73	113.81	39.93	40.34	98.00	92.68	81.43
8.	Average fruit weight (g)	2.04	4.29	3.17	20.43	20.96	95.00	1.30	41.03
9.	Ascorbic acid (mg/100g)	123.27	171.69	147.22	8.73	8.91	96.00	25.93	17.61
10.	Capsaicin content(%)	0.12	0.58	0.35	41.60	41.79	99.10	0.30	85.32
11.	Leaf curl incidence (%)	13.32	68.82	34.19	29.65	51.62	33.00	11.99	35.07
12.	Fruit length (cm)	3.96	12.31	7.96	29.21	29.90	95.40	4.68	58.79
13.	Fruit diameter (mm)	5.90	12.53	9.16	18.81	19.39	94.10	3.45	37.59
14.	Fruit yield per plant (g)	47.66	656.91	356.75	43.28	43.36	99.60	317.44	88.98

GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of variation, h^2 = Heritability,
GA = Genetic advance, GAM = Genetic advance as percent of mean.

Table 2: Estimates of phenotypic (P) and genotypic (G) correlation coefficient for different horticultural traits in chilli.

Traits		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	P	**1.000**	0.163	0.764**	0.696**	0.135	0.282*	-0.210	-0.078	-0.240	-0.030	0.075	-0.201	0.081	-0.159
	G	**1.000**	0.174	0.793**	0.745**	0.149	0.329*	-0.212	-0.080	-0.242	-0.030	0.112	-0.211	0.089	-0.160
2	P		**1.000**	0.212	0.264*	0.175	-0.061	0.491**	0.039	0.115	0.411**	-0.074	0.022	-0.162	0.426**
	G		**1.000**	0.259*	0.329*	0.238	-0.096	0.531**	0.023	0.129	0.442**	-0.126	0.020	-0.215	0.464**
3	P			**1.000**	0.613**	0.205	0.078	-0.304*	0.081	-0.377**	0.024	-0.110	-0.232	0.154	-0.233
	G			**1.000**	0.678**	0.200	0.070	-0.315*	0.085	-0.394**	0.027	-0.285*	-0.234	0.150	0.241
4	P				**1.000**	-0.034	0.288*	0.068	-0.100	-0.117	0.105	-0.108	-0.055	0.063	0.065
	G				**1.000**	-0.009	0.345**	0.083	-0.105	-0.134	0.117	-0.244	-0.056	0.086	0.068
5	P					**1.000**	0.111	0.162	0.325*	-0.398**	0.060	-0.086	0.167	0.080	0.256*
	G					**1.000**	0.197	0.190	0.375**	-0.507**	0.070	-0.036	0.212	0.096	0.295*
6	P						**1.000**	0.116	-0.244	-0.118	-0.007	0.055	-0.066	-0.111	-0.018
	G						**1.000**	0.132	-0.290*	-0.133	0.013	0.079	-0.058	-0.161	-0.028
7	P							**1.000**	-0.093	0.295*	0.449**	-0.182	0.284*	-0.275*	0.862**
	G							**1.000**	-0.091	0.307*	0.458**	-0.325*	0.292*	-0.291*	0.869**
8	P								**1.000**	0.075	-0.243	0.008	0.312*	0.516**	0.365**
	G								**1.000**	0.084	-0.257*	0.023	0.329*	0.528**	0.376**
9	P									**1.000**	0.264*	-0.126	-0.275*	-0.095	0.388**
	G									**1.000**	0.272*	-0.180	-0.287*	-0.086	0.395**
10	P										**1.000**	-0.153	-0.255*	-0.582**	0.285*
	G										**1.000**	-0.266*	-0.265*	-0.607**	0.288*
11	P											**1.000**	-0.007	0.016	-0.195
	G											**1.000**	0.061	0.011	-0.346**
12	P												**1.000**	0.085	0.367**
	G												**1.000**	0.096	0.376**
13	P													**1.000**	0.029
	G													**1.000**	0.030

* and ** indicate significant at 5% and 1% level, respectively.

1. Plant height (cm) after 150 DAT
2. Number of branches 150 DAT
3. Plant spread (E-W) at 150 DAT
4. Plant spread (N-S) at 150 DAT
5. Days to flower Anthesis
6. Days to first harvest
7. Fruits per Plant
8. Average fruit weight(g)
9. Ascorbic acid content (mg/100g)
10. Capsacin content
11. Leaf curl incidence (%)
12. Fruit length (cm)
13. Fruit diameter (mm)
14. Fruit yield per plant (g)

Table 3: Estimates of direct and indirect effect of different horticultural traits on fruit yield per plant at phenotypic (P) and genotypic (G) levels in chilli.

Traits		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	P	**0.0945**	0.0155	0.0722	0.0659	0.0128	0.0267	-0.0199	-0.0074	-0.0228	-0.0029	0.0072	-0.0190	0.0077	-0.1590
	G	**0.2554**	0.0445	0.2026	0.1905	0.0383	0.0841	-0.0543	-0.0205	-0.0620	-0.0077	0.0288	-0.0540	0.0229	-0.1601
2	P	-0.0081	**-0.0494**	-0.0105	-0.0131	-0.0087	0.0031	-0.0243	-0.0019	-0.0057	-0.0204	0.0037	-0.0011	0.0080	0.4269
	G	-0.0668	**-0.3837**	-0.0995	-0.1264	-0.0914	0.0370	-0.2037	-0.0089	-0.0498	-0.1698	0.0485	-0.0078	0.0827	0.4647
3	P	-0.0063	-0.0017	**-0.0082**	-0.0050	-0.0017	-0.0006	0.0025	-0.0007	0.0031	-0.0002	0.0009	0.0019	-0.0013	-0.2334
	G	-0.1218	-0.0398	**-0.1535**	-0.1041	-0.0307	-0.0108	0.0485	-0.0131	0.0605	-0.0042	0.0439	0.0359	-0.0231	-0.2410
4	P	0.0001	0.0000	0.0000	**0.0001**	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0650
	G	0.2571	0.1136	0.2338	**0.3447**	-0.0034	0.1192	0.0286	-0.0365	-0.0462	0.0406	-0.0842	-0.0196	0.0298	0.0682
5	P	0.0016	0.0021	0.0025	-0.0004	**0.0122**	0.0014	0.0020	0.0040	-0.0048	0.0007	-0.0011	0.0020	0.0010	0.2568
	G	0.0649	0.1032	0.0868	-0.0042	**0.4332**	0.0857	0.0823	0.1626	-0.2199	0.0307	-0.0159	0.0920	0.0417	0.2957
6	P	0.0091	-0.0020	0.0025	0.0093	0.0036	**0.0321**	0.0037	-0.0078	-0.0038	-0.0002	0.0018	-0.0021	-0.0036	-0.0182
	G	-0.2052	0.0600	-0.0440	-0.2153	-0.1232	**-0.6229**	-0.0828	0.1807	0.0829	-0.0081	-0.0496	0.0365	0.1004	-0.0281
7	P	-0.1925	0.4488	-0.2780	0.0623	0.1480	0.1065	**0.9133**	-0.0852	0.2699	0.4107	-0.1664	0.2601	-0.2519	0.8621
	G	-0.1696	0.4237	-0.2519	0.0663	0.1516	0.1061	**0.7980**	-0.0731	0.2450	0.3660	-0.2600	0.2333	-0.2328	0.8690
8	P	-0.0306	0.0153	0.0318	-0.0395	0.1274	-0.0955	-0.0365	**0.3912**	0.0293	-0.0951	0.0032	0.1222	0.2019	0.3658
	G	-0.0174	0.0050	0.0184	-0.0229	0.0813	-0.0628	-0.0198	**0.2165**	0.0183	-0.0557	0.0050	0.0713	0.1144	0.3764
9	P	-0.0363	0.0174	-0.0569	-0.0177	-0.0602	-0.0178	0.0446	0.0113	**0.1508**	0.0398	-0.0190	-0.0416	-0.0143	0.3887
	G	-0.0638	0.0341	-0.1037	-0.0353	-0.1335	-0.0350	0.0807	0.0222	**0.2629**	0.0717	-0.0475	-0.0755	-0.0226	0.3954
10	P	-0.0002	0.0028	0.0002	0.0007	0.0004	0.0000	0.0031	-0.0017	0.0018	**0.0068**	-0.0010	-0.0017	-0.0040	0.2857
	G	-0.0019	0.0274	0.0017	0.0073	0.0044	0.0008	0.0285	-0.0160	0.0169	**0.0620**	-0.0165	-0.0165	-0.0377	0.2888
11	P	-0.0017	0.0017	0.0025	0.0025	0.0020	-0.0012	0.0041	-0.0002	0.0029	0.0035	**-0.0226**	0.0002	-0.0004	-0.1951
	G	0.0029	-0.0033	-0.0074	-0.0064	-0.0010	0.0021	-0.0085	0.0006	-0.0047	-0.0069	**0.0260**	0.0016	0.0003	-0.3460
12	P	-0.0009	0.0001	-0.0010	-0.0002	0.0007	-0.0003	0.0012	0.0013	-0.0012	-0.0011	0.0000	**0.0043**	0.0004	0.3678
	G	-0.0327	0.0032	-0.0362	-0.0088	0.0329	-0.0091	0.0452	0.0510	-0.0445	-0.0411	0.0095	**0.1548**	0.0150	0.3762
13	P	0.0044	-0.0088	0.0084	0.0034	0.0043	-0.0060	-0.0150	0.0280	-0.0052	-0.0316	0.0009	0.0046	**0.0543**	0.0293
	G	0.0163	-0.0392	0.0274	0.0157	0.0175	-0.0293	-0.0530	0.0961	-0.0156	-0.1105	0.0021	0.0176	**0.1818**	0.0307

Residual effect (P) = 0.1472, (G)=0.1267; Bold values indicate direct effects.

1.Plant height (cm) after 150 DAT
2. Number of branches 150 DAT
3. Plant spread (E-W) at 150 DAT
4. Plant spread (N-S) at 150 DAT
5. Days to flower Anthesis
6. Days to first harvest
7. Fruits per Plant
8. Average fruit weight(g)
9. Ascorbic acid content (mg/100g)
10. Capsaicin content
11. Leaf curl incidence (%)
12. Fruit length (cm)
13. Fruit diameter (mm)
14. Fruit yield per plant (g)

expression of genetic relationship of characters in the phenotype. Number of fruits per plant significantly positive correlated with number of branches at 150 DAT, days to flower initiation, number of fruits per plant, average fruit weight, ascorbic acid content, fruit length, capsaicin content suggested that effective improvement in chilli through these component could be achieved by simple selection. These results are in consonance with the earlier researcher for number of fruits per plant (Ibrahim *et al.* 7; Sreelathakumary and Rajamony, 12; Bhardwaj *et al.,* 3), fruit weight (Mishra *et al.,* 11; Manna and Paul, 10). The significant association for average fruit length, number of fruits, fruit length suggests that increase in any one of these traits may result in increase in fruit yield per plant. Bharadwaj *et al*. (3) and Manna and Paul (10) also advocated that the importance should be given to number of fruits per plant, average fruit weight, number of branches per plant and fruit length during selection process because these characters contribute directly towards yield.

At genotypic level, number of fruits per plant had the highest positive direct effect on yield per plant (Table 3) followed by days to flower anthesis (0.4332), plant spread (N-S) (0.3447), average fruit weight (0.2165) while negative direct effect was observed for number of branches (-0.3837), days to first harvest (-0.6229) and plant spread (E-W) (-0.1535). High direct and positive effect of fruit weight and number of fruits per plant (Mishra *et al.*, 11) have been reported.

CONCLUSION

In the direct and indirect contributions of component traits towards fruit yield, selection on the basis of horticultural traits viz., number of fruits per plant, and average fruit weight would be paying preposition in the genotypes included in the study.

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EFFECT OF CALCIUM NITRATE ON PHYSICO-CHEMICAL CHANGES AND SHELF-LIFE OF AONLA (*Emblica officinalis* Gaertn) FRUITS

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ABSTRACT : The experiment was conducted at the Department of Horticulture, C.S.A. University of Agriculture and Technology, Kanpur during the year 2006-07 to find out effect of calcium nitrate on physico-chemical changes and shelf-life of aonla fruit. Completely Randomized Design (CRD) was selected with four treatments of calcium nitrate (0.5, 1.0 and 1.5 per cent with control) and four other treatments of cultivars (Banarasi, Krishna, Kanchan and NA-7) and 5 days, 10 days and 15 days of storage period. Experiments unit was 1 kg fruit in perforated polythene bags. Fruits were treated and stored on 17 November, 2006. As regards among the treatments tried as post-harvest dip at 1.0 per cent calcium nitrate treatment proved most effective in respect to increase physico-chemical qualities and shelf-life of aonla fruits. The 1.0 per cent calcium nitrate treated fruits significantly reduced the physiological loss in weight, pathological loss, exhibited better quality on account of its favourable effect on total soluble solids, total sugar and in retaining more ascorbic acid and acidity thereby rendering them acceptable upto period of 15 days. Different cultivars could keep well up to 5 days with 'Excellent' rating, 10 days with 'Good' rating while only NA-7 and Krishna with 'Fair' rating upto 15 days.

Keywords : *Aonla, calcium nitrate, cultivars, self-life, quality.*

Aonla belongs to the family Euphorbiaceae. It is called by several names in different parts of country *e.g., amalaki, amal, amali* and *ambala* etc. Its cultivation is since immemorial time in India. Aonla has become an important fruit (Chadha, 1). It is more popular in Uttar Pradesh, where it is largely cultivated in the district of Pratapgarh, Azamgarh, Varanasi and Jaunpur (Bajpai and Shukla, 2). At present, in production aonla ranks next to mango in U.P., Pratapgarh has been declared as aonla fruit belt and Agri-export zone (Prasad and Singh, 14).

The fruit is capsular with fleshy exocarp and it has very high nutritive and medicinal qualities. Chopra and Nagask (6) pointed out that fermented liquor of fruit is used in dyspepsia and cough. It is richest source of Vitamin 'C' and also contains fair amount of minerals and organic compounds.

During storage losses are fruit weight, decay and nutritional quality. The pathological losses in fruits start soon after the harvesting which requires systematic study on shelf-life and storage stability of aonla fruits. A wide variation in physico-chemical composition has been recorded in different cultivars of aonla (Pathak *et al.*, 13). Calcium plays an important role in maintaining the quality of fruit (Huber, 8).

MATERIALS AND METHODS

The experiment was carried out to find out effect of calcium nitrate on physico-chemical changes and shelf-life of aonla fruit at the Department of Horticulture, C.S.A. University of Agriculture and Technology, Kanpur during the year 2006-07. There were 16 treatments combinations, 4 treatment of calcium nitrate as 0.5%, 1.0%, 1.5% with control and 4 treatments of cultivars *i.e.* Banarasi, Krishna, Kanchan and NA-7. Duration of storage period was 5, 10 and 15 days and unit was 1 kg fruits/bag with three replications in Completely Randomized Design (CRD). The fruit samples were stored $16 \times 3 = 48$ under each storage period and analyzed after 5, 10 and 15 days. Calcium nitrate was dissolved in the distilled water and physico-chemical composition of fresh fruit was recorded immediately after

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harvest. The fruits of each cultivar were divided in four equal groups. Three groups of each cultivar dipped separately in 0.5, 1.0 and 1.5 per cent calcium nitrate solution and one group of each cultivar dipped in water for 30 minutes. Each group was kept in perforated bags after surface drying as per treatments and stored under ambient conditions.

Physiological loss in weight under each treatment was calculated after certain storage period. The pathological loss was calculated on weight basis. Total soluble solids content was recorded with the help of hand refractometer. Sample was taken from each treatment and drop of juice was placed on the glass of refractometer and values were corrected to 20°C with the help of temperature correction chart (AOAC, 1). Acidity was estimated in terms of malic acid titrated against NaOH solution using phenolphthalein as an indicator. The ascorbic acid content was calculated as mg/100 g of pulp by the method of AOAC (1). Total sugar content was estimated with the help of 'Fehling solution method'. Organaleptic evaluation was made by the panel of four judges on the basis of various quality attribute viz., appearance of fruits, taste, flavour and aroma, colour and texture and rating marks were allotted out of 100. Mark score was 0-40 'poor rating', 41-60 'fair', 61-80 'good' and 81-100 'excellent'.

RESULTS AND DISCUSSION

The result obtained in present investigation reveal that different post harvest calcium nitrate treatments on aonla fruit influenced various parameters (Table 1). The physiological loss in weight is an important parameter in maintaining the freshness of the fruit (Kumar *et al.,* 10). The physiological loss in weight per cent of fruits increased with the progress of storage. The minimum per cent physiological loss in weight was recorded in 1.0% Ca $(NO_3)_2$ after 5 days (5.02%), 10 days (7.29%) and 15 days (15.37%) followed by 1.5% Ca $(NO_3)_2$, whereas maximum was under control. Among the cultivars, maximum physiological loss in weight was found in Banarasi (20.66%) and minimum in NA-7 (14.39%) after 15 days of storage. All the cultivars exhibited lower physiological loss when treated with calcium nitrate (1.0%) as compared to untreated ones. However the degree of loss increased with the progress of storage. Faust (7) reported that the highest weight loss of untreated fruits is due to increased storage breakdown associated with higher respiratory rate as compared to calcium nitrate treated fruits. The present observations are supported by Nath *et al*. (12) and Singh (18).

The pathological loss (%) of fruit was significantly lower in 1.0% Ca $(NO_3)_2$ treated fruits as compared to remaining treatments after different storage periods. The higher pathological loss was recorded in control (17.09%) and it was lowest in 1.0% Ca $(NO_3)_2$ treatment (2.55%). Among cultivars, the minimum pathological loss was found in NA-7 after different storage period while maximum was found in Banarasi (18.84%) after 15 days of storage. Spoilage was mainly due to blue mould as reported by Singh and Kumar (19) and spoilage of fruits during storage by blue mould in aonla reported by Setty (16).

The ascorbic acid content in aonla fruits decreased under all the treatments with advancement of storage period. The higher content of ascorbic acid was observed in 1.0% Ca $(NO_3)_2$ (516.45 mg/100 g pulp) after 5 days of storage, while the lowest (419.40 mg/100 g) was in control after 15 days of observation. As regards the cultivar, the maximum ascorbic acid content was recorded in Banarasi, whereas minimum was in Krishna after differnet storage period. The results are supported by Kumar *et al.* (9) and Singh *et al*. (20).

The total soluble solids content exhibited increasing trend in all the cultivars under different treatments with the progress of storage period. The total soluble solids content was recorded maximum in 1.0% Ca $(NO_3)_2$ (13.20°Brix), Whereas, minimum was in control (11.55°Brix). Among the cultivars, maximum total soluble solids was found in Banarasi, while minimum was recorded in NA-7 after different storage periods. The

Table 1: Effect of calcium nitrate on physico-chemical changes of aonla.

Cultivar	After 5 days storage					After 10 days storage					After 15 days storage				
	Control (water dip) (T_0)	Ca $(NO_3)_2$ (0.5%) (T_1)	Ca $(NO_3)_2$ (1.0%) (T_2)	Ca $(NO_3)_2$ (1.5%) (T_3)	Mean	Control (water dip) (T_0)	Ca $(NO_3)_2$ (0.5%) (T_1)	Ca $(NO_3)_2$ (1.0%) (T_2)	Ca $(NO_3)_2$ (1.5%) (T_3)	Mean	Control (water dip) (T_0)	Ca $(NO_3)_2$ (0.5%) (T_1)	Ca $(NO_3)_2$ (1.0%) (T_2)	Ca $(NO_3)_2$ (1.5%) (T_3)	Mean
1. Physiological loss in weight (PLW)															
Banarasi (V_1)	6.45	6.24	5.91	6.18	6.19	11.85	10.39	9.35	10.28	10.46	22.34	21.25	18.34	20.69	20.66
Krishna (V_2)	6.01	5.83	5.37	5.77	5.74	10.29	9.35	8.45	9.28	9.34	20.89	19.28	16.47	18.39	18.75
Kanchan (V_3)	5.48	5.26	5.03	5.21	5.24	9.50	6.41	6.33	7.07	7.32	18.49	17.85	14.27	16.85	16.86
NA-7 (V_4)	4.37	4.19	3.78	4.29	4.09	9.03	6.40	5.03	6.38	6.71	15.89	15.29	12.38	14.01	14.39
Mean	5.57	5.38	5.02	5.29		10.16	8.13	7.29	8.25		19.40	18.41	15.37	17.48	
2. Pathological loss (%)															
Banarasi (V_1)	3.22	3.17	2.90	3.05	3.09	12.10	11.60	10.02	11.17	11.22	19.33	19.05	18.11	18.90	18.84
Krishna (V_2)	2.62	2.61	2.53	2.56	5.58	9.92	9.15	8.53	8.89	9.12	16.45	15.98	14.97	15.11	15.62
Kanchan (V_3)	2.89	2.85	2.71	2.75	2.80	10.25	10.07	9.12	9.75	9.79	17.46	17.15	16.14	16.99	16.93
NA-7 (V_4)	2.25	2.20	2.02	2.18	2.16	8.82	8.78	8.15	8.33	8.52	15.12	14.97	14.13	14.46	14.67
Mean	2.74	2.70	2.55	2.63		10.27	9.90	8.95	9.53		17.09	16.78	15.83	16.36	
3. Ascorbic acid content (mg/100 g)															
Banarasi (V_1)	603.54	609.68	620.32	614.64	612.04	564.34	572.47	594.27	586.25	579.33	512.65	536.28	579.38	552.68	545.24
Krishna (V_2)	439.65	446.79	454.48	449.95	447.71	405.38	416.78	431.82	422.78	419.19	378.45	391.45	410.29	402.46	395.66
Kanchan (V_3)	480.78	487.40	503.36	492.38	490.98	428.47	435.65	473.49	461.35	449.74	391.67	409.67	449.65	421.38	418.09
NA-7 (V_4)	472.08	478.54	487.65	481.50	479.94	425.68	431.42	471.58	454.64	445.83	394.84	405.42	452.84	425.55	419.66
Mean	499.01	505.60	516.45	509.61		455.96	464.08	492.79	481.25		419.40	435.70	473.04	450.51	

Contd......

table 1 contd..........

Cultivar	After 5 days storage					After 10 days storage					After 15 days storage				
	Cont-rol (water dip) (T_0)	Ca $(NO_3)_2$ (0.5%) (T_1)	Ca $(NO_3)_2$ (1.0%) (T_2)	Ca $(NO_3)_2$ (1.5%) (T_3)	Mean	Cont-rol (water dip) (T_0)	Ca $(NO_3)_2$ (0.5%) (T_1)	Ca $(NO_3)_2$ (1.0%) (T_2)	Ca $(NO_3)_2$ (1.5%) (T_3)	Mean	Cont-rol (water dip) (T_0)	Ca $(NO_3)_2$ (0.5%) (T_1)	Ca $(NO_3)_2$ (1.0%) (T_2)	Ca $(NO_3)_2$ (1.5%) (T_3)	Mean
4. Total soluble solids (TSS) (°Brix)															
Banarasi (V_1)	13.29	13.47	13.87	13.72	13.58	13.51	13.68	14.53	14.31	14.00	13.62	13.74	14.96	14.53	14.21
in0Krishna (V_2)	11.97	12.16	12.58	12.34	12.26	12.22	12.45	13.15	13.02	12.71	12.31	12.58	13.54	13.20	12.90
Kanchan (V_3)	10.62	10.76	11.21	11.05	10.91	10.79	10.90	11.78	11.46	11.23	10.90	11.17	12.31	11.90	11.57
NA-7 (V_4)	10.33	10.48	10.84	10.68	10.58	10.48	10.75	11.46	11.23	10.98	10.67	10.88	12.00	11.46	11.25
Mean	11.55	11.71	12.12	11.94		11.75	11.94	12.73	12.50		11.87	12.09	13.20	12.77	
5. Total sugars (%)															
Banarasi (V_1)	7.48	7.66	8.05	7.82	7.75	7.82	8.06	8.53	8.27	8.17	8.11	8.30	8.92	8.63	8.49
Krishna (V_2)	5.42	5.48	5.72	5.64	5.56	5.76	5.95	6.79	6.54	6.26	5.96	6.45	7.56	7.12	6.77
Kanchan (V_3)	4.05	4.28	4.86	4.73	4.48	4.43	4.75	5.98	5.65	5.20	4.65	5.54	6.83	6.08	5.77
NA-7 (V_4)	3.81	3.95	4.34	4.15	4.06	4.15	4.82	5.85	5.26	5.02	4.42	4.78	6.72	5.95	5.46
Mean	5.19	5.34	5.74	5.58		5.54	5.89	6.78	6.43		5.78	6.26	7.50	6.94	
6. Acidity content (%)															
Banarasi (V_1)	2.43	2.45	2.52	2.46	2.46	2.26	2.28	2.42	2.33	2.32	1.87	1.93	2.15	2.05	2.00
Krishna (V_2)	1.84	1.86	1.90	1.87	1.86	1.72	1.75	1.91	1.82	1.80	1.49	1.52	1.73	1.59	1.58
Kanchan (V_3)	1.93	1.94	2.00	1.96	1.95	1.82	1.83	1.93	1.86	1.86	1.51	1.58	1.81	1.63	1.62
NA-7 (V_4)	1.70	1.71	1.75	1.73	1.72	1.54	1.58	1.64	1.60	1.59	1.48	1.52	1.59	1.54	1.53
Mean	1.97	1.99	2.04	2.00		1.83	1.86	1.97	1.90		1.58	1.63	1.82	1.70	
7. Organoleptic rating evaluation															
Banarasi (V_1)	69.78	78.58	90.05	86.32	81.18	50.49	60.53	73.38	63.27	61.91	24.78	29.28	52.47	31.57	34.52
Krishna (V_2)	72.34	81.24	91.46	90.48	83.88	53.69	71.76	76.92	73.85	69.05	32.36	35.72	57.35	38.78	41.05
Kanchan (V_3)	69.62	85.68	93.37	89.53	84.55	49.37	64.38	75.17	68.92	64.46	29.98	32.46	56.95	35.28	38.66
NA-7 (V_4)	75.53	88.25	95.54	94.39	88.42	58.72	72.42	80.38	78.83	72.58	35.62	39.65	64.57	41.83	45.41
Mean	71.81	83.43	92.60	90.18		53.06	67.27	76.46	71.1		30.68	34.27	57.83	36.86	

highest total soluble solids (14.96°Brix) content was recorded under treatment combination of Banarasi and 1.0% Ca $(NO_3)_2$ after 15 days of storage. The result is in close proximity with findings of Kumar *et al.* (10) and Roychaudhary *et al.* (15).

The total sugar content in aonla fruit increased during storage (Table 1). The maximum total sugar content (8.49%) was recorded in Banarasi after 15 days of storage, while minimum was found in NA-7 (5.46). Among the treatments maximum total sugar content (7.5%) was noticed in 1.0% Ca $(NO_3)_2$. As regards the interaction effect, it was maximum (8.92%) under treatment of combination of V_1T_2 after 15 days of storage. The increased conversion of starch into sugar due to activation of hydrolytic enzymes by calcium could be responsible for increases in sugar content (Chahal and Bal, 5; Saba *et al.*, 16). Kumar *et al.* (10) also reported that aonla fruits treated with Ca $(NO_3)_2$ showed maximum sugar level.

The acidity content in per cent decreased in all the cultivars under different treatments with an increase in storage period. The maximum acidity (2.04%) was observed in 1.0% Ca $(NO_3)_2$ after 5 days of storage, whereas minimum was recorded in control (1.58%). Among the cultivars, highest acidity content was found in Banarasi (2.46%) after 5 days of storage and minimum (1.53%) in NA-7 after 15 days of storage. The acidity decrease in aonla fruit may be due to utilization of organic acid in respiration. Jha *et al.* (9) also reported that the acidity of mango fruits decreased with the advancement of storage period due to conversion of acids into salt and sugars by enzymes. With regard dipping 1.0% Ca $(NO_3)_2$ retained the maximum level of acidity in aonla fruit (Upadhyay and Dixit, 21).

The maximum organoleptic ratings were observed under the treatment of 1.0% Ca $(Na_3)_2$ and fruits were found "excellent and good" after 5 days and 10 days, respectively. Among the cultivars, NA-7 recorded maximum organoleptic value followed by Krishna, Kanchan and Banarasi. It may be assumed that higher rate of losses in weight during storage might have been due to raised energy requirement during storage. The results are supported by Bhalerao *et al.* (3) and Mir *et al.* (11).

On the basis of findings achieved in the present investigation it may be concluded that among the treatments tried as post-harvest dip, 1.0% Ca $(NO_3)_2$, treatment proved most effective with respect to physico-chemical qualities and shelf-life of aonla fruits. The calcium nitrate 1.0% treated fruits significantly reduced the physiological loss in weight, pathological loss exhibited higher organoleptic rating with longer shelf-life. Besides, the fruits also exhibited better in quality on account of its favourable effect on total soluble solids, total sugar and in retaining more ascorbic acid and acidity, thereby rendering them acceptable upto period of 15 days. Different cultivars could be keep well up to 5 days with "Excellent" rating, 10 days with "Good" rating while only NA^{-7} and Krishna with "Fair" rating upto 15 days.

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EVALUATION OF IVY GOURD (*Coccinia cordifolia* L.) GENOTYPES IN ALLAHABAD AGRO-CLIMATIC CONDITION

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ABSTRACT: An evaluation trial on ivy gourd (*Coccinia cordifolia* L.) genotypes in Allahabad agro climatic condition was conducted at vegetable research farm, Department of Horticulture, SHIATS Allahabad for 16 characters *i.e.* days to first female flower anthesis, plant height, internodal length, petiole length, fruit length, fruit daimeter, average fresh fruit weight, number of seeds/fruit, number of fruits per plant, yield per plant, yield per hectare, TSS (°Brix) and ascorbic acid content. Eight genotypes of ivy gourd, namely Arka Neelachal Sabuja, Arka Neelachal Kunkhi, AAIIG – 1, AAIIG – 2, AAIIG – 3, AAIIG – 4, AAIIG – 5 and AAIIG – 6 were evaluated in randomized block designed in three replication during 2011. The genotype AAIIG – 1 and Arka Neelachal Sabuja showed minimum days to female flower anthesis. The highest fruit length and fruit diameter were obtained by Arka Neelachal Kunkhi and AAIIG – 1, respectively and maximum fruit weight was exhibited by genotypes AAIIG – 1. The most promising genotype was AAIIG – 1 for maximum number of fruit per plant and fruit yield per plant followed by Arka Neelachal Sabuja.

Keywords: *Ivy gourd evaluation, high yielding, genotypes, anthesis.*

Ivy gourd (*Coccinia cordifolia* L.) is an underexploited cucurbitaceous perennial vegetable crop. It is an aggressively climbing vine that spread quickly over trees, shrubs, fences or other supports. It is grown mostly in homestead farms for tender fruits in almost all regions of the country. Immature fruits are used for cooking which are rich sources of carbohydrates, protein and vitamin A & C, Medicinally this vegetable is gaining importance among diabetic patients. It bears fruits almost throughout the year where mild winter prevails. In regions where severe winter occurs, it bears fruit for 8-9 months. Although this is considered as a an underutilized vegetable, it is grown extensively in Chhattisgarh, West Bengal, Bihar and Karnataka on a commercial scale and giving remunerative returns to farmers. Availability of better cultivars and knowledge of many other preparations and uses of this crop can propel its evolution from an underutilized species to an important horticultural crop in Indian agriculture. But unfortunately till today no systematic research has been initiated in university and private institutions. Hence the evaluation trial on ivy gourd (*Coccinia cordifolia* L.) genotypes was initiated at Department of Horticulture, SHIATS, Allahabad to help the vegetable growers.

MATERIALS AND METHODS

The investigation was carried out during 2011 at Department of Horticulture, Allahabad School of Agriculture, SHIATS, Allahabad. Eight genotypes were collected from Orissa, Chhattisgarh and Allahabad and planted in single row planting in randomized block design with three replications on vegetable research farm. Each experimental unit was represented 10 plants spaced at 1 meter, row spaced 1.5 meter and the plants were trained on trellis system. The fertilizer dose of 60:40:40 kg NPK/ha was given in 3 equal installments at every 30 days. Observation on growth parameters-days to first female flower anthesis, plant height, internodal length, petiole length (Table 1), yield parameters fruit length, fruit daimeter, average fresh fruits weight, number of seed/fruit, number of fruits per plant, yield per plant, yield per hectare (Table 2) and quality parameters-TSS and ascorbic acid (Table 3) were recorded on 5 plants from every genotype in each replication. The data was subjected to statistical analysis as suggested by Panse and Sukhatme (4).

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Table 1: Mean performance of Ivy gourd genotypes for growth parameters.

S. No.	Genotype	Days to first female flower anthesis	Plant height (cm)	Internodal length (cm)	Petiole length (cm)
1	Arka Neelachal Sabuja	39.33	369.00	11.10	3.90
2	Arka Neelachal Kunkhi	56.67	296.67	07.83	2.53
3	AAIIG-1	39.33	289.77	10.10	4.10
4	AAIIG-2	46.00	318.55	12.47	6.63
5	AAIIG-3	44.00	322.00	11.77	5.73
6	AAIIG-4	51.33	293.67	08.57	3.57
7	AAIIG-5	43.33	255.00	06.60	6.60
8	AAIIG-6	41.00	310.00	08.17	8.17
	C.D. (P = 0.05)	7.16	54.59	1.01	0.77

Table 2: Mean performance of Ivy gourd genotypes for yield parameters.

S. No.	Genotype	Fruit length (cm)	Fruit diameter (cm)	Average fresh fruit weight (g)	Number of seeds/ fruit	Number of fruits / plant	Yield per plant (kg)	Yield per hectare (t)
1	Arka Neelachal Sabuja	6.17	2.80	26.00	206.00	365.33	5.98	14.95
2	Arka Neelachal Kunkhi	8.27	1.97	18.00	182.67	210.00	3.10	07.76
3	AAIIG-1	5.40	3.05	27.67	243.33	428.00	7.81	19.51
4	AAIIG-2	4.50	2.70	20.64	165.33	251.33	3.45	08.63
5	AAIIG-3	5.30	2.94	26.67	188.00	272.33	4.11	10.27
6	AAIIG-4	5.67	2.24	18.00	149.33	286.00	4.07	10.23
7	AAIIG-5	5.93	2.09	16.00	176.67	188.00	2.82	07.06
8	AAIIG-6	4.33	2.04	09.67	143.67	218.67	3.03	07.59
	C.D. (P=0.05)	0.45	0.24	4.99	18.14	53.59	0.56	1.40

Table 3: Mean performance of Ivy gourd genotypes for quality parameters.

S. No.	Genotype	TSS (°Brix)	Ascorbic Acid	B : C ratio
1	Arka Neelachal Sabuja	3.70	14.70	2.74
2	Arka Neelachal Kunkhi	2.90	12.70	1.42
3	AAIIG-1	4.06	15.37	3.58
4	AAIIG-2	3.28	14.33	1.58
5	AAIIG-3	3.07	13.90	1.89
6	AAIIG-4	2.75	13.27	1.88
7	AAIIG-5	3.28	12.87	1.30
8	AAIIG-6	2.87	12.27	1.39
	C.D. (P=0.05)	0.26	0.42	

Arka Neelachal Sabuya

Arka Neelachal Kunkhi

RESULTS AND DISCUSSION

Growth attributing characters of Ivy gourd (Table 1) like days to first female flower anthesis was singnificantly more in Arka Neelachal Kunkhi (56.67 days) and least was noticed in AAIIG -1 (39.33 days) and Arka Neelachal Sabuja (39.33 days). Plant height was singnificantly more in Arka Neelachal Sabuja (369 cm), whereas in AAIIG – 1 it was 289.11 cm and least was noticed in AAIIG – 5 (255 cm). The variation in plant height might have been due to internodal length, petiole length, genetic characters and morphological characters. Similar result was recorded by Dharmatti *et al.* (2).

Internodal length was significantly more in AAIIG – 2 (12.47 cm) followed by AAIIG – 1 (10.1 cm) and least was noticed in AAIIG – 5 (6.6 cm). Petiole length was signicficantly more in AAIIG – 6 (8.17 cm) and least was noticed in Arka Neelachal Kunkhi (2.53 cm). Similar opinions were expressed by Maharana *et al.* (3) in spine gourd.

The yield attributing characters (Table 2) like fruit length, fruit diameter, average fresh fruit weight, number of seeds per fruit, number of fruits/plant directly influence on the yield/plant and yield/ha. The fruit length was significantly more in Arka Neelachal Kunkhi (8.27 cm) followed by Arka Neelachal Sabuja (6.17 cm) whereas in AAIIG – 1 it was 5.4 cm and least was noticed in in AAIIG–6 (4.33 cm). Fruit diameter was significantly more in AAIIG – 1 (3.05 cm) and least was noticed in Arka Neelachal Kunkhi (1.97 cm). The variation in fruit length might have been due to internodal length, plant height, genetic characters and morphological characters. Similar results were recorded by Dharmatti *et al.* (2).

The data indicate that average fresh fruit weight of AAIIG – 1 (27.67 g) was significantly superior than the other genotypes and less fruit weight was observed in AAIIG – 6 (9.67 g) confirming to results of Dharmatti *et al.* (2).

Number of seeds/fruit was significantly more in AAIIG – 1 (243.33) followed by Arka Neelachal Sabuja (206) and least was noticed in AAIIG – 6 (143.67) supporting the finding Bhave *et al.* (1) in bitter gourd.

Number of fruits/plant was significantly more in AAIIG – 1 (428) followed by Arka Neelachal Sabuja (265.33) and least was noticed in AAIIG – 5 (188). The variation in number of fruits per plant might have been due to internodal length, plant height, genetical variation and morphological characters. Similar result was recorded by Dharmatti *et al.* (2).

Among the 8 genotypes, AAIIG – 1 produced significantly higher fruit yield/plant during first 15 harvesting. The average fruit yield/plant of AAIIG – 1 genotypes was 7.81 kg followed by Arka Neelachal Sabuja (5.98 kg) and least was noticed in AAIIG – 5 (2.82 kg). Similar trend was noticed for yield/ha. The genotype AAIIG – 1 was recorded significantly higher yield/ha as compared to other genotypes. The average yield/ha of AAIIG – 1 genotype was 19.51 t/ha followed by Arka Neelachal Sabuja (14.95 t/ha) and least was noticed in AAIIG – 5 (7.06 t/ha). These results were in accordance with Dharmatti *et al.* (2).

The quality parameters of Ivy gourd fruit (Table 3) revealed that the genotype AAIIG -1 was significantly superior for all the traits. The more TSS and ascorbic acid were observed in AAIIG – 1 (4.06 °Brix, 15.37 mg/ 100 g fruit pulp) followed by Arka Neelachal Sabuja (3.70 °Brix, 14.7 mg/ 100 g fruit pulp). The least TSS was observed in AAIIG – 4 (2.75 °Brix) and least ascorbic acid was observed in AAIIG – 6 (12.27 mg/ 100 g fruit pulp). Similar results were reported by Ramchandaran and Gopalkrishnann (5) in bitter gourd.

CONCLUSION

From the present investigation it was concluded that the ivy gourd genotype "AAIIG – 1" resulted in the highest fruit diameter, fresh fruit weight, number of fruits per plant, yield per plant, yield per hectare, TSS, ascorbic acid and Benefit Cost ratio (3.58) followed by genotypes Arka Neelachal Sabuja giving higher yield per plant and yield per hectare, respectively.

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STUDY ON POST-HARVEST LIFE OF CUT ROSE CV. FIRST RED AS AFFECTED BY DIFFERENT CHEMICALS AND WRAPPING MATERIALS

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ABSTRACT: An investigation was carried out to find the effect of different chemicals as pulsing solutions ($CaCl_2$ 1%, Sucrose 5% + 8HQC 150 ppm, Sucrose 3% + $Al_2(SO_4)_3$ 300 ppm for duration of 20 and 24 h) and wrapping materials (Newspaper, Butter paper and Cellophane sheet for duration of 16 h) on the quality and vase life of cut rose cv. First Red. Results obtained show that all treatments performed better than that of control. Among all the treatments, A_2C_2 (cut rose pulsed with Sucrose 5% + 8HQC 150 ppm for 20 h and packaged with Butter paper for 16 h) recorded the maximum increase in quality and vase life of 12.34 days. Whereas the treatments A_2C_0 (pulsed with Sucrose 5% + 8HQC 150 ppm for 20 h only) and A_0C_2 (packaged with Butter paper for 16 h only) recorded a vase life of 11.13 days and 11.02 days, respectively. However, in control treatment (A_0C_0) the vase life recorded was 8.53 days.

Keywords : *Cut rose, pulsing, wrapping, duration, post-harvest life*

Rose is one of the major cut flower, well adapted to various climatic conditions and occupies the premier position in the domestic and international markets. Cut rose are highly perishable in nature and need to be treated to improve their vase life and postharvest quality. They are deprived of their natural sources of water and nutrients after harvest. The major constraints in export of cut roses from our country are poor packaging, inadequate facilities in transport and treatments required to facilitate prolonged shelf life. Added and ideal package is necessary to maintain low rate of respiration and transpiration. It is therefore, important to workout postharvest management of roses to minimize losses and make rose growing more remunerative (Bhattacharjee, 2*)*. Hence, present study was undertaken to find out the response of effective pulsing solution and suitable packaging materials to prolong the vase life of cut rose cv. First Red.

MATERIALS AND METHODS

The experiment was conducted in the research laboratory of Department of Horticulture, C.C.S University Campus Meerut during 2007-2008. The cultivar First Red of cut rose was procured from Ikram 'G' Florist, Begum Bridge Meerut. The cut rose stems were harvested early in the morning at tight bud stage between 7.00-8.30 am and were brought to the laboratory by placing them in a bucket containing fresh water. The flowers were recut to a uniform length of 35 cm and only three uppermost leaves were retained. The maximum and minimum temperatures fluctuated between 17-22°C and relative humidity was 60-75% during the course of investigation. The different chemicals/pulsing solutions used for pulsing cut rose stems are $CaCl_2$ 1% (A_1), Sucrose 5% + 8HQC 150 ppm (A_2), Sucrose 3% + $Al_2(SO_4)_3$ 300 ppm (A_3) for duration of 20 h and 24 h and different wrapping materials used for packaging are Newspaper (C_1), Butter paper (C_2) and Cellophane sheet (C_3) for duration of 16 h. After different treatments of pulsing and packaging the cut rose stems were kept individually in equal sized test tubes containing 60 ml of distilled water for vase life evaluation. However, the control treatment A_0C_0, where no pulsing or packaging was done, the stems were directly placed in distilled water for evaluation. The present experiment was laid out in factorial randomized block design consisting of sixteen treatments, each of them replicated thrice. Observations were recorded changes in fresh

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weight, flower diameter, water uptake and vase life of cut rose stems.

RESULTS AND DISCUSSION

All the pulsing and wrapping treatments were found to be superior over the control treatment (Table 1). Among all the treatment combinations of pulsing and wrapping, A_2C_2 (flowers pulsed with Sucrose 5% + 8HQC 150 ppm for 20 h and packaged with Butter paper for 16 h) recorded the highest gain in fresh weight of 2.71 g followed by 2.59 g in A_2C_3 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and packaging with Cellophane sheet for 16 h) and 2.50 g in A_3C_2 (pulsing with Sucrose 3% + $Al_2(SO_4)_3$ 300 ppm for 24 h and packaging with Butter paper for 16 h) on 3rd day in vase as revealed in Table 1. The increase in fresh weight before senescence was also reported by Pal *et al.* (10). However, the treatments A_2C_0 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and no packaging) and A_0C_2 (no pulsing but packaging with Butter paper for 16 h) recorded the gain in fresh weight of 2.29 g and 1.90 g respectively on 3rd day as shown in Table 1. Similar reports of gain in fresh weight and vase life of cut rose have been reported by Beaura and Singh (1), Srivastava *et al*., (14) and Paine and Paine (9). In control treatment A_0C_0, gain in fresh weight recorded was 1.10 g.

The least reduction in fresh weight at senescence recorded was -1.33 g in treatment A_2C_2 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and packaging with Butter paper for 16 h) followed by -1.52 g in A_2C_3 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and packaging with Cellophane sheet for 16 h) as revealed in Table 1. However, in treatments A_2C_0 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and no packaging) and A_0C_2 (no pulsing with Butter paper packaging) the reduction in fresh weight of -2.37 g and -2.46 g at senescence was observed. In control treatment A_0C_0, the reduction in fresh weight at senescence was -2.96 g (Table 1). Similar report of least reduction in fresh weight at senescence was reported by Singh (12). Matile and Winkenbach (7) reported the loss in fresh weight at senescence due to reduced level of starch and proteins. Similarly Nowak and Rudnicki (8) reported that microorganism growing in vase water cause vascular blockage and produce ethylene, which accelerates senescence in cut flowers.

Data (Table 1) indicates that the maximum flower diameter of 3.38 cm on 3rd day in vase was recorded in treatment A_2C_2 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and packaging with Butter paper for 16 h) followed by 3.28 cm in A_2C_3 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and packaging with Cellophane sheet for 16 h) and 3.20 cm in A_3C_2 (pulsing with Sucrose 3% + $Al_2(SO_4)_3$ 300 ppm for 24 h and packaging with Butter paper for 16 h). However, the treatments A_2C_0 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and no packaging) and A_0C_2 (no pulsing with Butter paper packaging for 16 h) recorded the maximum flower diameter of 3.08 cm and 3.03 cm on 3rd day as shown in Table 1. In control treatment A_0C_0, the flower diameter on 3rd day recorded was 2.94 cm (Table 1). The maximum flower diameter after complete opening 4.31 cm was recorded in treatment A_2C_2 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and packaging with Butter paper for 16 h) followed by 4.18 cm in A_2C_3 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and packaging with Cellophane sheet for 16 h) and 4.04 in A_3C_2 (pulsing with Sucrose 3% + $Al_2(SO_4)_3$ 300 ppm for 24 h and packaging with Butter paper for 16 h) as evident from Table 1. However, the treatments A_2C_0 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and no packaging) and A_0C_2 (no pulsing with butter paper packaging for 16 h) recorded the flower diameter of 3.82 cm and 3.78 cm after complete opening. In control treatment (A_0C_0), the flower diameter after complete opening recorded was 3.68 cm (Table 1). Similar results of increase in flower diameter were reported by De and Bhattacharjee (3), Sivaswamy and Bhattacharjee (13) and Beaura and Singh (1).

The maximum water uptake on 3rd day 12.89 ml was recorded in treatment A_2C_2 (cut roses pulsed with Sucrose 5% + 8HQC 150 ppm for 20 h

Table 1: Post-harvest life of cut rose cv. First Red as affected by different chemicals and wrapping materials.

Treatment	Changes in Fresh Weight (g)		Changes in Flower Diameter (cm)		Changes in Water Uptake (ml)		Vase Life (days)
	on the 3rd day in vase	at senescence day	on the 3rd day in vase	after complete opening	on the 3rd day in vase	at senescence day	
A_1C_1	2.31	-2.33	3.09	3.86	11.10	31.07	11.19
A_1C_2	2.46	-2.14	3.16	3.95	11.72	31.82	11.52
A_1C_3	2.46	-2.20	3.12	3.92	11.36	31.40	11.50
A_1C_0	2.15	-2.40	3.03	3.78	10.99	30.84	11.05
A_2C_1	2.43	-2.25	3.11	3.91	11.36	31.14	11.43
A_2C_2	2.71	-1.33	3.38	4.31	12.89	33.66	12.34
A_2C_3	2.59	-1.52	3.28	4.18	12.11	32.82	12.14
A_2C_0	2.29	-2.37	3.08	3.82	11.05	31.03	11.13
A_3C_1	2.49	-2.07	3.19	4.03	11.77	32.40	11.60
A_3C_2	2.50	-1.91	3.20	4.04	12.03	32.68	11.74
A_3C_3	2.42	-2.32	3.10	3.91	11.22	31.10	11.23
A_3C_0	2.27	-2.38	3.07	3.80	11.02	30.93	11.12
A_0C_1	1.25	-2.91	3.01	3.73	10.76	30.06	10.87
A_0C_2	1.90	-2.46	3.03	3.78	10.96	30.82	11.02
A_0C_3	1.25	-2.67	3.02	3.76	10.92	30.48	10.97
A_0C_0	1.10	-2.96	2.94	3.68	10.74	29.21	8.53
C.D (P=0.05)	0.39	0.42	0.02	0.03	0.34	2.11	0.17

and packaged with Butter paper for 16 h) followed by 12.11 ml in A_2C_3 (flowers pulsed with Sucrose 5% + 8HQC 150 ppm for 20 h and packaged with Cellophane sheet for 16 h) and 12.03 ml in A_3C_2 (pulsing with Sucrose 3% + $Al_2(SO_4)_3$ 300 ppm for 24 h and packaging with Butter paper for 16 h) as revealed in Table 1. However, the treatments A_2C_0 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and no packaging) and A_0C_2 (no pulsing with Butter paper packaging for 16 h) recorded the maximum water uptake of 11.05 ml and 10.96 ml on 3rd day in vase as shown in Table 1. In control treatment A_0C_0 (no pulsing and no packaging), the water uptake on 3rd day recorded was 10.74 ml (Table 1). The maximum water uptake 33.66 ml at senescence was recorded in treatment A_2C_2 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and packaging with Butter paper for 16 h) followed by 32.82 ml in A_2C_3 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and packaging with Cellophane sheet for 16 h) and 32.68 ml in A_3C_2 (pulsing with Sucrose 3% + $Al_2(SO_4)_3$ 300 ppm for 24 h and packaging with Butter paper for 16 h) as evident from Table 1. However, the treatments A_2C_0 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and no packaging) and A_0C_2 (no pulsing with butter paper packaging for 16 h) recorded the water uptake of 31.03 ml and 30.82 ml at senescence (Table 1) In control treatment A_0C_0, the water uptake at senescence recorded was 29.21 ml.

Increased water uptake was achieved by maintenance of cell integrity which was also confirmed by Halevy and Mayak (4). Similar results of increase in water uptake were reported by Jothi and Balakrishnamoorthy (5) and Reddy *et al.* (11).

Data (Table 1) indicates that the maximum vase life 12.34 days was recorded in treatment A_2C_2

(pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and packaging with Butter paper for 16 h) followed by 12.14 days in A_2C_3 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and packaging with Cellophane sheet for 16 h) and 11.74 days in A_3C_2 (pulsing with Sucrose 3% + $Al_2(SO_4)_3$ 300 ppm for 24 h and packaging with Butter paper for 16 h). However, the treatments A_2C_0 (pulsing with Sucrose 5% + 8HQC 150 ppm for 20 h and no packaging) and A_0C_2 (no pulsing with Butter paper packaging for 16 h) recorded the vase life of 11.13 days and 11.02 days, respectively. In control treatment A_0C_0, the maximum vase life recorded was 8.53 days (Table 1).

Similarly Jothi and Balakrishnamoorthy (5) reported that quality and longevity of cut rose can be improved by treating them with specific pulsing solutions and packaging materials. According to Kaul (6) the chemicals 8HQC and alumunium sulphate directly improved the vase life by minimizing bacterial damages and acidifying the vase solution. The water retention property of Butter paper is better than the other uncoated papers and is hygroscopic in nature (Paine and Paine, 9). Cellophane sheet has thin foil which permits partial gas exchange, thus preventing injury due to excess CO_2 (Bhattacharjee, 2).

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FABA BEAN: UNIQUE GERMPLASM EXPLORED AND IDENTIFIED

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ABSTRACT: The germplasm contains promising traits related to yield and yield attributing characters, quality characters and also resistance to various biotic and abiotic stresses. Exploration for collection of germplasm of diverse nature is the quickest and simplest method for acquiring the desired one. 71 accessions of faba bean were collected from Bihar and evaluated. Unique germplasm explored and identified and notable among them are salt resistant lines explored and collected from Vaishali district of Bihar. One germplasm line having four pods per nod and another one bear fruits right from collar region were identified during the course of characterizations and evaluation. These promising and unique accessions will be used by breeders/ crop improvement workers in the country for its evaluation and further utilization in their ongoing/ensuing crop improvement works for strengthening food and nutritional security of country.

Keywords: *Faba bean, germplasm, collection, identification, exploration.*

Faba bean is an important legume consumed throughout the world. The cultivated forms of faba bean are grown in different agroclimatic conditions depending upon the suitability of the accessions to a particular area. However, in general the cultivars (as in most other crops) are susceptible to many biotic and abiotic stresses leading to lower yields of the crop. It becomes imperative to look for resources which can provide resistance to such stresses. This would mean broadening the genetic base of the cultivars which is essential for starting any breeding program for crop improvement. Wild relatives of faba bean, possessing such genes/traits imparting resistance to biotic and abiotic stresses would be ideal for plant breeders (Torres *et al*., 6). Faba bean (*Vicia faba* L.) is also known as broad bean, horse bean, field bean, windsor bean in various languages, in Hindi it is popularly known *Kala Matar* and *Bakala.* It is one of the oldest crops having long tradition of cultivation in old world agriculture. Globally, faba bean (*Vicia faba* L.) is third most important feed grain legume after soybean (*Glycine max*) and pea (*Pisum sativum* L.) with a total production of 4.87 MT and harvested area of 2.63 Mha, as reported by Mihailovic *et al*. (3). Faba bean is seen as an agronomically viable alternative to cereal grains. Faba bean, being a legume, is a nitrogen-fixing plant are capable of fixing atmospheric nitrogen, which results in increased residual soil nitrogen for use by subsequent crops. It is one of the best annual crop which can be used as green manure having potential of fixing free nitrogen (100-350kg N /ha). It can be grown in adverse soil conditions (soil pH). Faba bean are grown during winter in subtropical and warmer temperate climates on water remaining after crops such as maize and sorghum. Though the crop is widely adapted to diverse soil types, and is more tolerant towards acidic as well as saline alkaline soils than most legumes. Being so incredible crop, unfortunately in India it is categorized as minor, underutilized, less utilized, and still not fully exploited crops. It's only because of lack of cultivar. Only two varieties namely "Pusa Sumit" (released in 1998 by IARI) and "Vikrant" (VH-82-1) released in 1999 by HAU, Hisar) have been released at all India level so for. Lack of faba bean improved variety lead to undertake this project to develop new faba bean variety for food and nutritional security of Eastern Region.

Greater insight into the pattern and dynamics of genetic resources of faba bean (*Vicia faba* L.) is needed in order to understanding and establishing the relationship among collected germplasm from Bihar region. Characterization and preliminary evaluation is the one of the important technique which helps in to elucidate the extent and pattern of

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Fig. 1 : Faba bean germplasm being evaluated under field conditions.

agro-morphological as well as molecular diversity in this crop. The diversity assessment of the germplasm available also serves as a tool in devising proper conservation strategies. The 'hot spots' for the diversity can be identified among different landraces to prioritize their conservation. For both *ex-situ* as well as *in-situ* conservation the knowledge of the extent of diversity present is a prerequisite (Bond, 1). Genotyping or germplasm analysis is required for correct placement of the species into the genepools that can be used in breeding programes. *V. faba* does not have a secondary gene pool as its wild relatives are not known and the distantly related *Vicia* species viz. *V. narbonensis, V. hyaeniscyamus, V. galilaea, V. johannis,* and *V. bithynic* constitutes its tertiary gene pool (Zohary and Hopf, 7; Cubero, 2 and Muehlbauer *et al.,* 4). Absence of the secondary gene pool further underscores the importance of phenotypic as well as genotypic diversity assessment of the primary gene pool. Because of this technical difficulties of achieving interspecific crosses with *V. faba,* only natural variability is available to breeders It is necessary to have knowledge of the diversity present in the germplasm to be used in its breeding programmes and its analysis by genotyping and phenotyping will be of great benefit to breeders. It enables them to develop varieties or cultivars suited to different agroclimatic zones or different seasons. Faba bean is susceptible to many pests and pathogens and to different abiotic stresses. The resistant germplasm identified among the germplasm is used for development of resistant varieties.

MATERIALS AND METHODS

Total 71 accessions were collected during the designated exploration. All the accessions, which were collected from this exploration, were planted at main research farm of ICAR Research Complex for Eastern Region for evaluation. November planted crop generally flowers in January- February and complete its lifecycle in the month of March. The field evaluation (Fig.1) was conducted during *Rabi* seasons of 2009-10 and 2010-11. All the accessions were given equal care. Unique germplasm explored and collected and further identified. The unique germplasm having traits of economic importance is described as under :

RESULTS AND DISCUSSION

Salt resistant faba bean line explored

An exploration trip was undertaken to collect available germplasm in the Vaishali District of Bihar to strengthen faba bean germplasm collections. At Chakramdas this salt resistant line (Fig. 2) of faba bean has been explored and collected. Only few plants of faba bean were present on white crusted field. Though this crop was sown as mixed cropped with mustard which is a tolerant to salinity but failed grossly even to germinate under such soil conditions where these plants were surviving enough.

Evaluation and identification of promising traits

In order to efficiently use of faba bean germplasm in breeding program, genetic diversity and main characters were assessed in a collection of 71 faba bean germplasm from Bihar. The result showed that the germplasm resources had high genetic diversity, with a quality (Singh *et al.,* 5). Tow unique germplasm has been identified as mentioned below.

Fig. 2 : Salt resistant faba bean line explored from Vaishali District of Bihar.

Faba bean lines bear's four pods per node:

Total 71 accessions were screened and evaluated for various agro-morphological and yield attributes, seed yield and quality. One line has been identified having four pods per node (Fig. 3). This character is very unique as this is not very commonly seen feature. This trait may be utilized for further faba bean improvement programme.

Fig. 3 : Faba bean accession bearing four pods per node.

Faba bean line bear's pods from collar regions

One line among the other promising lines was found bearing pod right from collar region (Fig 4).

Fig. 4 : Faba bean line bear's pods from collar region.

This trait is very important for improving production potential, as this line recorded 95.5 to 121 g seed yield per plant.

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RESPONSE OF DIFFERENT SPACING AND SALICYLIC ACID LEVELS ON GROWTH AND FLOWERING OF GLADIOLUS (*Gladiolus grandiflora* L.)

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ABSTRACT: An experiment was conducted to assess the effect of spacing and salicylic acid levels on vegetative growth and flowering of gladiolus cv. White Properity at HRC, SVPUAT, Meerut. The three levels of spacing (20 x 10, 20 x 20, and 20 x 30 cm) and three levels of salicylic acid (0, 50 and 100 ppm) were used in randomized block design (RBD) with three replications. Out of these a optimum spacing 20 x 20 cm was found superior with 100 ppm salicylic acid concentration in respect of number of leaves, leaf length (cm), days to opening of 1st floret and visibility of first spike, spike length, and number of florets per spike.

Keywords : *Gladiolus, spacing, salicylic acid, spike yield.*

Gladiolus is a popular cut flower crop belonging to family Iridaceae which is originated from South Africa. The cut flower is popular for its attractive spikes having florets for huge form, dazzling colours, varying sizes and long keeping quality. Due to its longer vase life, it is used in various floral arrangements like vase-arrangement, bouquet, hall arrangement, dice arrangement etc. It is a most important flowering plant having fourth rank in international market in world cut flower trade. Now-a-days, it is gaining fast popularity in India because the use of its flowers for floral arrangements in metro cites. Therefore, the demand of gladiolus is increasing in international as well as domestic market due to it high value.

Quality flower production of gladiolus is a big challenge for our florist. To obtain good material of gladiolus spacing plays an important role for good growth, quality spikes and cormel production (Bijimol and Singh, 1). Keeping in view the present study was carried out to find out the optimum level of spacing and salicylic acid dose for vegetative growth and high quality cut spikes of gladiolus cv. White Prosperity.

MATERIALS AND METHODS

An experiment on the effect of spacing and salicylic acid levels on vegetative growth and flowering of gladilous (*Gladiolus grandiflora* L.) cv. White Prosperity was carried out at Horticulture Research Centre (HRC), Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (UP) during 2007-08. The experiment was laid out in a factorial randomized block design with 9 treatments and three replications Fully developed medium size corms were taken for planting purpose and treated with carbendazim @ 2.0 g per litre water and dried in shade. The treated corms were planted in well prepared field at the spacing *i.e.,* 20 x 10, 20 x 20 and 20 x 30 cm. The foliar application of salicylic acid was done according to doses *i.e.* 0, 50 and 100 ppm uniformly at 40 and 60 days after planting during cropping period. A recommended dose of nitrogen, phosphorus and potash was applied in field. The half dose of nitrogen and full dose of phosphorus and potash were applied as basal dose at the time of final preparation of field before planting of corms. Whereas, remaining half dose of nitrogen was applied at the time of first flower spike emergence. During the experimentations, data were recorded in terms of growth and flowering parameters by using standard methods. Statistical analyses were carried out as suggested by Gomez and Gomez (2).

RESULTS AND DISCUSSION

Data presented in Table 1 showed that the different levels of spacing and salicylic acid application significantly affected the growth parameters during the course of investigation.

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Maximum plant height (105.32 cm) was observed with 20 x 20 cm spacing whereas minimum plant height was recorded under the closer spacing i.e. 20 x 10 cm over the wider spacing i.e. 20 x 30 cm. Similar results were also recorded in respect of plant height. The maximum plant height (105.32cm) was noticed with a optimum spacing 20 x 20 cm and minimum (103.59 cm) under closer spacing i.e. 20 x 10 cm as compared to other wider spacing 20 x 30 cm. The number of leaves, length of leaf and width of leaf were also significantly affected by using various levels of spacing. The maximum of leaves per plant (12.63), length of leaf (67.28 cm) and width of leaf (3.01 cm) were recorded with optimum level of spacing i.e. 20 x 20 cm while minimum number of leaves (9.56), length of leaf (64.44 cm) and width of leaf (3.01 cm) were recorded under the closer spacing i.e. 20 x 10 cm after the second wider spacing 20 x 30 cm. It is might be due to the space providing between the plants. The optimum plant spacing is provide the optimal amount of nutrients, space, sun light etc. regarding the number of sprouts and plant height. Similarly maximum number of leaves per plant, length of leaf and width of leaf are due to the effect of sufficient space and maximum exposure to sun light which enhance the photosynthesis. These findings are closely related with the findings of (Sujatha and Singh, 3).

Similarly, the various doses of salicylic acid in the form of foliar application exhibited the significant effect on different growth parameters as compared to control and other treatments during the experimentation. The maximum plant height (104.83 cm) was recorded with an application of 50 ppm salicylic acid and minimum plant height (99.45 cm) was obtained under the control treatment after the higher level of salicylic acid *i.e*., 100 ppm. The other parameters like number of leaves per plant, leaves per plant, leaf length and width were also significantly increased upto zero to 100 ppm salicylic acid. The maximum number of leaves per plant (11.83), length of leaf (68.64 cm) and width of leaf (3.03 cm) were observed with higher level of salicylic acid (100 ppm), while minimum number of leaves (8.73), length of leaf (64.86 cm) and width of leaf (2.74 cm) were recorded in control treatment. The salicylic acid is gave the favourable effect on growth parameters, because it is a growth promoting chemical. It accelerates the cell divisions in the apical portion of the sprouts in gladiolus. The above findings are in close confirmity with the findings of Sakhabut-dinova *et al*. (4).

The data pertaining to flowering parameters (Table 2) revealed that the various levels of spacing and salicylic acid significantly affected the flowering of gladiolus over the control. The minimum days taken in terms of visibility of spike and days to opening 1st floret *i.e.* 93.24 and 105.17 days were recorded under the wider spacing 20 x 30 cm, whereas maximum visibility days of first spike (104.04) and days to opening 1st floret (115.97 days) were taken with spacing *i.e.* 20 x 10 cm followed by optimum spacing 20 x 20 cm with values i.e. 97.88 and 110.64 days in terms of visibility of first spike and days to opening of 1st florets. Similar results were also obtained with different doses of salicylic acid. In this regard, the minimum visibility of 1st spike (90.77 days) and days to opening 1st floret (102.27 days) were noticed under the higher dose of salicylic acid i.e., 100 ppm. However, the maximum days taken to visibility of first spike and days to opening of 1st floret (108.09 and 119.38 days, respectively) were noticed in control.

In context of spike length, the maximum length of spike (96.53 cm) was observed with wider spacing 20 x 30 cm, whereas minimum length of spike was noted under closer spacing i.e. 20 x 10 cm followed by optimum spacing 20 x 20 cm. The salicylic acid concentration were also significantly affected the spike length upto 50 ppm salicylic acid then it was noted as detrimental factor. The maximum length of spike (101.54 cm) was recorded under 50 ppm salicylic acid whereas, minimum (86.14 cm) was obtained under control followed by higher concentration of salicylic acid. The another flowering character like rachis length

Table 1 : Effect of spacing and salicylic acid on vegetative growth characters of gladiolus.

Treatments	Plant height (cm)	No. of leaves / plant	Leaf length (cm)	Leaf width (cm)
Spacing				
S_1 (20 10 cm)	101.62	9.56	64.44	2.78
S_2 (20 20 cm)	105.32	10.64	66.91	2.90
S_3 (20 30 cm)	103.59	12.63	67.28	3.01
Salicylic acid				
H_0 (0 ppm)	99.45	8.73	64.86	2.74
H_1 (50 ppm)	104.83	9.06	65.03	2.93
H_2 (100 ppm)	101.24	11.83	68.64	3.03
C.D. (P = 0.05)	1.81	0.30	1.11	0.05

Table 2 : Effect of spacing and salicylic acid on flowering characters of gladiolus.

Treatments	Visibility of first spike (days)	Days to opening of 1st floret	Spike length (cm)	Rachis length (cm)	Floral diameter (cm)	No. of florets / spike
Spacing						
S_1 (20 10 cm)	104.04	115.97	90.61	95.07	10.68	11.08
S_2 (20 20 cm)	97.88	110.64	94.37	67.95	10.70	12.86
S_3 (20 30 cm)	93.24	105.17	96.53	66.45	40.90	14.45
Salicylic acid						
H_0 (0 ppm)	108.09	119.38	86.14	64.75	10.80	11.95
H_1 (50 ppm)	96.51	108.13	101.54	69.70	11.00	12.97
H_2 (100 ppm)	90.77	102.27	93.83	59.70	11.10	14.97
C.D. (P = 0.05)	2.16	1.75	2.11	0.70	NS	1.33

were also noted in favourable trend. The longest rachis length (95.07 cm) was recorded with closer spacing 20 x 10 cm and minimum (66.45 cm) was reported under 20 x 30 cm spacing followed by 20 x 20 cm. The rachis length significantly affected by salicylic doses also with increasing level upto zero to 50 ppm then it was declined with higher concentration i.e., 100 ppm salicylic acid. The maximum (69.70 cm) rachis length was recorded with a dose of 50 ppm salicylic acid, while minimum (59.70 cm) rachis length was observed with 100 ppm salicylic acid followed by control (64.75 cm).

The floral diameter was affected significantly with all the levels of spacing and salicylic acid. The various spacing and salicylic acid concentrations were significantly affected the number of florets per spike with increasing levels of both the treatments over control. The maximum number of florets (14.45) were found under wider spacing 20 x 30 cm whereas, minimum number of florets (11.08) were recorded under the closer spacing followed by 20 x 20 cm spacing. Similar results were also reported with various concentration of salicylic acid. The maximum number of florets per spike (14.97) were observed with 100 ppm salicylic acid and minimum number of florets (11.95) were under control followed by 50 ppm salicylic acid. The positive response of wider spacing provide sufficient space between the plants resulting plants absorbed optimum amount of nutrients with sufficient light, which ultimately favours photosynthesis and translocation of assimilates into the storage organs.

These changes in plant system are also responsible for improving flowering parameters i.e., visibility, days to open 1st floret, spike length, rachis length, floral diameter and number of florets. These findings are in close conformity with the earlier findings reported by Khurana and Cleland (5).

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ECONOMICS OF PRODUCTION AND MARKETING OF OKRA IN DISTRICT BIJNOR (U.P.)

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ABSTRACT: Bhindi (Okra) is an important vegetable crop of district Bijnor. It provides a net income of Rs. 7794.78 with a gross output value of Rs. 21000.00 with a total input of Rs. 13205.22. The cost : benefit ratio was calculated at 1:1.59. In the marketing of Bhindi(okra) the producer's share in the price paid by the consumer was very low being only 56.41 per cent due to inefficient marketing. A sound production and marketing system of vegetables in general and that of *Bhindi* (okra) in particular are needed.

Keywords : *Okra, production, marketing, economics, cost : benefit ratio.*

Vegetable growing has assumed increased interest by the farmers during the last few decades with the commercialization of agriculture. *Bhindi* is cultivated throughout India for its immature fruits which are generally cooked as vegetable. *Bhindi* soups and stews are also popular dishes. When ripe, the black or brown white eyed seeds are sometimes roasted and used as substitute for coffee. The crop is used for the extraction of the fiber. The fruits also have some medicinal value.

Now a days, India is one of the main vegetable growing countries of the world. Bhindi crop is grown all over India. Among the most important states only four U.P., Maharashtra, M.P. and Tamil Nadu account three fourth of total area (Schweers and Sims, 3).

An attempt was made here to collect primary data and analyze it to find out certain special features which would reveal a broad picture of production and marketing of Bhindi in Bijnor district of U.P. with the special objectives viz. To study the economics of production of Bhindi, economics of the existing arrangement for marketing, and to examine the problems of production and marketing of *Bhindi* and put forth suggestion to overcome them

MATERIALS AND METHODS

The present study was confined to Kotwali block of Bijnor district. The data were collected from 5 villages of the Kotwali block by contacting 50 *Bhindi* growers who were randomly selected for the purpose. The block was selected most suited for *Bhindi* cultivation. The data were collected by survey method through personal interview with the respondents during 2009-10. The data on marketing were collected from the Bijnor vegetable Mandi which is a secondary market and regulated one.

RESULTS AND DISCUSSION

For the sake of convenience, the present study has been divided into three parts : 1. Economics of production of Bhindi, 2.Marketing of Bhindi,and 3. Problems and Suggestions.

1.Economics of Production of Bhindi:

The farmers of the Kotwali block of district Bijnor generally grow Pusa Makhamali and Pusa Sawani varieties of *Bhindi* which are high yielding varieties. The *Bhindi* growers in the study area generally apply, 3-4 ploughings, 1 to 2 weedings and 2-3 irrigations for its production. They generally use 300 to 400 quintals of F.Y.M along with chemical fertilizers in the form of N.P.K.

Cost and Returns : The cost structure in production of Bhindi included the cost on production inputs like seed, irrigation, plant protection, manures and fertilizers, human labour and tractor power, rental value of land at the prevailing market rate and overhead costs, comprising of interest on working and fixed capital, repairs and depreciation etc. The average cost on

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inputs and returns on the cultivation of *Bhindi* per hectare on the sample holdings have been workout (Table 1).

Table 1 reveals that the cost of production per hectare of *Bhindi* (cost of cultivation and marketing charges per hectare) came to Rs. 16040.22. The cost of production per quintal was worked out to Rs. 229.15. As regards returns, Bhindi yielded a net return of Rs. 4959.78, with a total value of output of Rs. 21000.00. The average yield came to 70.00 quintals per hectare. As regards expenditure on different items, human labour accounted for the highest percentage expenditure being 19.81 to the total cost followed by cost on manures and fertilizers (19.07%), marketing cost (17.70%), seed (14.40%), tractor power (7.20%), irrigation (3.41) and plant protection (3.41%).

(2) Marketing of *Bhindi* :

Method of Sale : Marketing of *Bhindi* plays a very vital role in the production process of this crop. In Kotwali market both wholesale and retail sale are followed. Wholesalers and retailers, in fact, purchase the Bhindi from producers and sale it to retailers or consumers. *Bhindi* is offered for sale in the market directly by producers themselves also.

Market Charge : The marketing charges paid by the producers per quintal of Bhindi in Bijnor vegetable mandi has been shows in Table 2.

Table 2 shows that the marketing cost per quintal of *Bhindi* in Bijnor vegetable mandi, which is under regulation, came to Rs. 40.50 per quintal. As regard marketing charges of different items, commission accounted for the highest percentage expenditure being 37.04 to the total marketing charges followed by packing charges 20.99%, transportation 23.46%, *mandi* charge and other 12.34% and loading and unloading charges 6.17%.

During the course of investigation, it was observed that the prices were the highest in the month of October to January and the lowest from March to September. The position of prices become worst during the period when the trucks are not free available. The findings of present study are in line of Maurya *et al.* (1).

Producer's Share in Consumer's Price : It would be interesting to know the difference between price received by the producer and price paid by the ultimate consumer and its spread over in the marketing of *Bhindi* in Bijnor. Several factors are governing the fraction or percentage of price obtained by the producer. Thus, whole spectrum of such factors are rural roads, market distance from production centres, marketing news, economic condition of farmers and marketing facilities etc. The producer's share in consumer's price in Bijnor vegetable *Mandi* for the year 2009-10 has been worked out in Table 3.

Table 3 reveals that the producer's share in consumer's price in Bijnor vegetable *Mandi* came to 56.41%. This low level of producer's share in consumer's price may be attributed towards inefficient markeing. The marketing costs and margins accounted for 43.59%. The marketing cost born by the producer came to 8.80% and those of wholesaler and retailers 16.54%. The middle men's margin came to 18.25% of the price paid by the consumers. The per quintal expenditure borne by the producers of the wholesaler and the retailer come to Rs. 40.50, Rs. 42.50 and Rs. 33.50, respectively. The middlemen's share came to Rs. 84.00 per quintal.

(3) Problems and Suggestions : The main problems related to Bhindi production, transportation, marketing etc. and suggestions (Loranz and Maynard, 2) thereof are summarised in the following lines. By and large, the problems of *Bhindi* centre round the fact that the margin of profit in this commodity has been decreasing and to not in consistent with the quantum of investment.

(i) Supply of inputs and quality seed : There are only two improved varieties of *Bhindi i.e.* Pusa Makhamali and Pusa Sawani which are grown in the study area. It is suggested that new improved, hybrid, high yielding varieties of *Bhindi* and the supply of other farm inputs at reasonable price and

Table 1 : The average cost and returns on *Bhindi* crop (year 2009-10).

S. No.	Particulars	Value in Rs/ ha	Percentage
1	Human labour	3176.59	19.81
2	Traction power	1155.00	7.20
3	Seed	2309.99	14.40
4	Manures and fertilizers	3063.14	19.07
5.	Irrigation	498.81	3.11
6	Plant protection	498.81	3.11
7	Rental value of land	1500.00	9.35
8	Overhead charges	1002.10	6.25
9	Total cost of cultivation	13205.22	
10	Average yield in quintal	70.00	
11	Average marketing rate per quintal	300.00	
12	Total value of produce	21000.00	
13	Net profit	7794.78	
14	Cost benefit ratio	1:1.59	
15	Cost of production/qtl. of Bhindi	108.65	
16	Marketing cost per quintal	40.50	
17	Total marketing cost of the product of one quintal	2835.00	
18	Cost of production/q of Bhindi including marketing charges	229.15	
19	Total input cost/ha including market charges	16040.22	
20	Net return per hectare	4959.78	

Table 2 : Marketing charges per quintal of *Bhindi* paid by producer during 2009-10.

S. No.	Particulars	Marketing charges per quintal in Rs.	Percentage
1	Packing charges	8.50	20.99
2	Transportation	9.50	23.46
3	Commission	15.00	37.04
4	Loading and unloading	2.50	6.17
5	*Mandi* charges & others	5.00	12.34
	Total	40.50	100.00

Table 3 : Producer's share in consumer's price (2009-10).

S. No.		Particulars	Amount in Rs. per quintal	Percentage of consumer's price
A	1.	Charges paid by producer	40.50	8.80
	2.	Sale price of producer	300.00	
	3.	Net amount received by producer	259.50	
B	1.	Charges paid by wholesaler	42.50	9.24
	2.	Sale price of wholesaler	380.50	
	3.	Wholesaler's margin	37.50	8.15
C	1.	Charges paid by retailer	33.50	7.30
	2.	Sale price of retailer	460.00	
	3.	Retailer margin	46.50	10.10
D.		Producers share in consumer's price	259.50	56.41

at proper time will help in increasing the productivity of the produce to a large extent.

(ii) Development of varieties : The development of varieties with better culinary quality and superior nutritive value, exploring possibilities of increasing processing and industrial use of bhindi is needed, improving the existing techniques for producing disease free seed, pollen storage pollination, flower production and fruiting studies aimed at helping in breeding programme.

(iii) Diseases, insects and pests : Bhindi is attracted by a number of diseases caused by fungi and viruses. The fungus can live in the soil for several years; so the control measures consist on soil treatment or use of fungus resistant varieties. spraying with some copper fungicides also can prevent the spread of the disease.

The most important virus diseases is yellow vein mosiac. It is a vein clearing virus disease. There is no resistant commercial variety. Pusa Sawani is a variety tolerant to the disease. The disease infestation is greater in the rainy season than in summer.

There are a number of insects, which attack bhindi but only jassids are often serious, the other insects are shoot and fruit borer and cotton bollworms. The control measures for Jassids are timely spraying with a 0.02% Endrine or 0.04% monocrotophas. The treatment should not be given, when the crop is ready for harvest.

(iv) Low producer's share in consumer's price: The producer's share in consumer's price was very low in the study area and requires immediate remedial measures. The efficient transport and credit facilities may go a long way in raising the producer's share in consumer's price on one hand and reducing the marketing cost of the other.

(v) Distress sale of Bhindi : Immediate remedial measures are need to save the bhindi growers from distress sale. Efficient transport and other facilities on one hand and increased export on the other hand would go a long way in solving this problem.

(vi) High transport cost : The transport cost forms a major part of the marketing cost to the producer as well as the traders. Steps may be taken at the government level to regularize the transport charges. For this purpose monopoly of the transport agencies will have to be broken and control rate be in forced.

(vii) Low price : It has been observed that during the year there has been a very wide fluctuation in the prices. No doubt, price fluctuation of bhindi is one of the various problems of marketing.

(viii) Large surpluses : In order to increase the profitability of the crop, it is suggested that the supply at a reasonable rate must be increased. For this purpose, news outside the country should be explored on priority basis. Export promotion council should take up the issue of supply of bhindi more seriously.

A multi-directional integrated approach to take up problem solving and purpose oriented research, which may enable growers to play a vital role in the agricultural economy of the state.

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Research Note :

IDENTIFICATION OF FABA BEAN (*Vicia faba* L.) LINES SUITABLE FOR RAINFED AND IRRIGATED SITUATION

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Keywords : *Faba bean, germplasm, selection technique, line.*

Faba bean (*Vicia faba* L.) is one of the oldest crops grown by man and is used as a source of protein in human diet, as fodder and forage crop for animals, and for available nitrogen in the biosphere. It is popularly called as "Bakla" in Hindi heartland. They were introduced to India by Arab traders. The name is derived from Arabic name "Baquila". In spite of its potential, the total area of faba bean cultivation has steadily decreased in many countries over the last century (Mihailovic *et al.,* 3 and Singh and Bhatt, 4). To make faba bean into a perfect candidate for a sustainable agriculture, the crop should be beneficial both to farmers/producers and to users (human and/or animal nutrition). This goal could be achieved through the development of genotypes resistant to diseases and abiotic constraints such as over-wintering ability, frost resistance and drought avoidance, and free of anti-nutritional factors (Cubero, 2, and Singh *et al.*, 5). There are two types of faba bean i.e. large seeded *Vicia faba* major, commonly known as broad bean, and the smaller *Vicia faba* minor, sometimes known as tick or horse bean(Alba and Scippa, 1). In fact, the two types are the same species and are only distinguished on the basis of seed size. Faba bean being such potential crop but it is very unfortunate to say but is reality in India this crop is by and large known as orphan and this crop is still treated as neglected crop, resulted in to limited systematic crop improvement work in past (Singh and Bhatt, 4).

Only few serious attempts has been undertaken to breed out improved cultivar for this crop, hence only two varieties (Pusa Sumeet and Vikrant) are notified till date so far at national level Average potential productivity of both variety is 1.5-3.5 t/ha. In India it is grown as intercrop under irrigated condition with potato, maize, wheat even sole cropping is also done, whereas under rainfed conditions it is grown as sole crop and also as mixed/intercropped with several crops including lentil, linseed, gram etc. (Singh *et al.,* 5 and Singh *et al.,* 6).

Lack of suitable varietal technology is one of the major bottlenecks to adopt this crop. Farmers are bound to cultivate low yielding disease susceptible local landraces. The potentiality of faba bean is around 6.0-7.0 t /ha whereas in India its average productivity is1.5 t/ha and in Bihar it is further low to 1.2 t/ha. Keeping in view the above facts one project was undertaken with an objective to evaluate faba bean germplasm for agro-morphological, physiological and quality traits and development of suitable faba bean varietal technology. Under project B7-1 evaluation of germplasm of faba bean (*Vicia faba* L.). 68 accessions of faba bean were collected during 2005-06 and being evaluating since 2006-07, all together leading to sustainable improvement of land and water productivity. To take lead in world trade we have to come with suitable package and practices of faba bean to improve our production and productivity. With Immediate objectives viz., to evaluate the promising germplasm under multi-location trials, to evaluate the performance of promising germplasm under different environment and to recommend promising lines as variety for different situation. Varietal technology is the tool to provide potential to act upon other technology to improve the production and productivity through efficient agronomic management practices. Keeping in view the above stated fact the multi-location trial was proposed to evaluate the developed and screen promising lines for its suitability to the particular environment. The important characteristic features of the developed lines are as under

Descriptions of developed line 2011215:

This line was developed by adopting selection method due to its added advantage of adaptability of screened and developed variety. Single plant selection method was adopted for further screening and fixing of desired trait. Selection was made from the germplasm collected from Bihar (Singh and Bhatt, 4). The plant height of this line is 70 – 90 cm depending upon soil type, agro-climatic condition

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Fig. 1 : Plant type and seed character of 2011215.

Fig. 2 : Plant type and seed character of 2011410.

and crop management practices adopted. It is semi spreading types (Fig.1) and matures in 110-115 days. This variety was developed for irrigated and rainfed both conditions. The yield potential of this line under irrigated (5.2 t/ha) and rainfed (4.0 t/ha). The major characteristic feature of this line is given in Table 1. Performance of this line (2011215) was evaluated under multilocation trial (Table 2). Seed yield was recorded 5.38 t/ha under irrigated and 3.94 t/ha in rainfed situation and better than both the national check i.e. Pusa Sumeet (2.68 t/ha.) and Vikrant (2.37 t/ha).

Descriptions of developed line 2011410:

Selection method was also applied to develop this line, obviously due to its added advantage of adaptability of screened and developed variety under particular agro-climatic conditions. Further screening and fixing of desired trait was done through single plant selection method. Selection was made from the germplasm collected from Bihar (Singh and Bhatt, 4). Depending upon agro-climatic condition, soil type and agronomic management practices plant height of this line ranged between 77-105 cm. Stature of plant is bushy types (Fig. 2). Crop matures in 120-125days. This line was developed exclusively for irrigated conditions. It performs excellent under assured water supplied condition. The yield potential of this line under irrigated is 5.5 to 6.0t/ha. The major characteristic feature of this line is given in Table 1. Performance of this line (2011410) was evaluated under multilocation trial (Table 2). Seed yield was recorded 5.05 t/ha under irrigated environment and better than both the national check i.e. Pusa Sumeet (2.68 t/ha.) and Vikrant (2.37 t/ha).

Good agronomic practices (GAP) for achieving potential production of developed lines

Square planting (keeping 30 cm apart) is advocated for both lines for better utilization of all the resources. Furrow irrigation and raised bed planting (FIRB) is the best management practice to optimize resources utilization. Both the developed lines are very much responsive to added nutrients. To produce faba bean seed @ 5.0 t/h, under sandy loam to clay loam soil condition with normal pH and medium soil fertility status, on an average, it requires N: P: K: S: Zn @ 25:60:40:30:5 kg/ha. It is essential to apply all nutrients as basal application, however for better yield and quality, top dressing of urea at pre-flowering stage after light irrigation may be done. Further foliar application of Zn @ 0.5 per cent and boron 50 ppm will make sure the increased productivity (Singh *et al.,* 7).

Table 1: Important characteristic of developed varieties (accessions).

Sl. No.	Traits	Descriptions of developed varieties (Accessions)	
		2011215	2011410
1.	Plant height	70–90 cm	77-105 cm
2.	Days to maturity	110-115	120-125
3.	Yield potential (t/h)	4.0 to 5.2	5.5 to 6.0
4.	HI	0.61	0.63
5.	1000 grain wt. (g)	235.6	228.9
6.	Leaf area Index (90DAS)	2.03	2.14
7.	Plant type	Semi spreading	Bushy
8.	1st podding height	5 cm	7.5 cm
9.	Recommended for	Irrigated as well as rainfed condition	Irrigated condition

Table 2: Multi location evaluation of developed lines of faba bean.

Location of Evaluation	Performance of faba bean (Seed yield t/ha)				
	Developed lines			Check variety	
	2011215 (Irrigated)	2011215 (Rainfed)	2011410 (Irrigated)	Pusa Sumeet (Irrigated)	Vikrant (Irrigated)
ICAR, Patna	5.53	3.16	5.38	2.91	2.36
ICAR, Ranchi	4.76	2.43	3.1.8	2.26	2.19
IARI, Pusa	6.13	2.29	5.88	2.86	2.51
WALMI, Patna	6.03	4.53	5.18	28.1	2.74
CPRS, Patna	5.23	2.43	4.58	2.91	2.57
KVK Auraiya	5.39	3.34	4.23	2.96	2.28
KVK, Sitamarhi	4.84	2.69	3.82	2.52	1.96
KVK, Buxar	5.11	2.67	3.89	2.17	2.34
Average	5.38	3.94	5.05	2.68	2.37

Rainfed: Irrigation was supplemented at pre flowering stage.
Irrigated: Irrigation (2-4 nos.) has been provided need based *i.e.* (Watering at pre flowering and post podding was must).

Summary :

Single plant selection (SPS) is the one of the best way to identify and purify the desirable traits. Both lines were screened and purified adopting the same technique. 2011215 is identified for rainfed and irrigated environment whereas 2011410 is best suited for irrigated condition. Both the lines were found suitable for Eastern States, viz. Eastern U.P., Bihar and Jharkhand.

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Research Note :

EFFECT OF FOLIAR APPLICATION OF ZINC AND BORON ON YIELD AND FRUIT QUALITY OF GUAVA (*Psidium guajava* L.)

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Keywords : *Guava, zinc, boron, foliar application, fruit quality.*

Guava (*Psidium guajava* L.) is one of the most important subtropical fruit crop. It is also called "The apple of tropics". It belongs to the natural order Myrtal and the botanical family Myrtaceae. Guava is a rich source of ascorbic acid and pectin, which ranges from 75 to 260 mg/100 g and pectin ranges between 0.5% to 1.8%, respectively. (Adsule and Kadam, 1). Besides, it is fair source of Vitamin A and contains appreciable quantities of thiamine, riboflavin and niacin. Guava fruit is also utilized to make products like Jelly, Jam, Cheese, Ice-cream and Toffee. Two types of wines-guava juice wine and guava pulp wine are also prepared from guava fruit.

Zinc is the important constituent of several enzymes which regulate various metabolic reaction in the plant, associated water uptake to water relation in the plant. The deficiency symptoms appear in younger leaves starting with interveinal chlorosis leading to a reduction in shoot growth and the shorting of internodes. Zinc is essential for auxin and protein synthesis, seed production and proper maturity. It also increases the fruit size as well as yield. Boron is a constituent of cell membrane and essential for cell division. Acts as a regulator of potassium/calcium ratio in the plant, helps in nitrogen absorption and translocation of sugar in plant. Boron increases nitrogen availability to the plant.

It is therefore, essential to evaluate the effect of zinc and boron and their combination on yield and fruit quality for their commercial application.

The investigation was conducted during 2011-2012 at the experimental orchard of Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture Technology and Sciences, Allahabad (U.P.). The soil of experimental orchard was sandy loam and site comes under sub-tropical zone. Average rainfall is above 900 mm. Nine treatments viz., T_0 – Control (tap water), T_1 – 0.5 per cent Boric Acid, T_2 – 0.6 per cent Boric Acid, T_3 - 0.5 per cent Zinc Sulphate, T_4 - 0.5 per cent Zinc Sulphate + 0.5 per cent Boric Acid, T_5 - 0.5 per cent Zinc Sulphate + 0.6 per cent Boric Acid, T_6 - 0.6 per cent Zinc Sulphate, T_7 - 0.6 per cent Zinc Sulphate + 0.5 per cent Boric Acid and T_8 - 0.6 per cent Zinc Sulphate + 0.6 per cent Boric Acid were applied on 15th July and 10th September, 2011.

The experiment was laid out in 3x3 Factorial in Randomized Block Design with three replications. Observations were recorded on yield and physico-chemical characters.

Fruit weight was significantly increased by the application of different treatments of micronutrients (Table 1). Maximum fruit weight (162.01 g) was observed with 0.6% zinc sulphate + 0.5% boric acid followed by T_8 (0.6% zinc sulphate + 0.6% boric acid) with 154.11g. Minimum fruit weight (85.55 g) was found in control. The higher fruit weight due to combined application of zinc and boron may be attributed to their stimulatory effect on plant metabolism. These results are in conformity with the results reported by El-Sherif *et. al.* (3), Das *et al.* (2), Singh *et al.* (7) and Rawat *et al*. (6).

The highest polar diameter (7.91 cm) was found in T_7 (0.6% zinc sulphate + 0.5% boric acid) and followed by T_8 with 7.14 cm. The minimum

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diameter (5.15 cm) was recorded in control. The radial diameter was significantly increased by the application of different treatments of zinc and boron. Maximum radial diameter (7.52 cm) was observed with T_7 followed by T_8 with 6.78 cm. The minimum diameter (4.62 cm) was found in control. The higher radial diameter of fruit due to combined application of zinc and boron may be attributed to their stimulatory effect of plant metabolism. (Das *et al.,* 2; Singh *et al.*, 7 and Rawat *et al.,* 6).

The treatment T_7 (0.6% zinc sulphate + 0.5% boric acid) have maximum yield (46.41 kg/plant) and followed by 0.6% zinc sulphate + 0.6% boric acid with 43.42 kg/plant and T_5 with 42.39 kg/plant, respectively. The minimum yield (23.71 kg/plant) was found in control. These results are more or less in conformity with the findings reported by Kundu and Mitra (5), El-Sherif *et al.* (3), Singh *et al.* (7) and Rawat *et al.* (6).

The maximum specific gravity (1.024 g/cc) was found in 0.6% zinc sulphate + 0.5% boric acid followed by T_8 with 1.012 g/cc. The minimum specific gravity (0.892 g/cc) was found in control.

Total soluble solids (TSS) was found maximum (15.40%) in T_7 followed by T_8 (0.6% zinc sulphate + 0.6% boric acid) with 13.61%. The minimum TSS (9.62%) was found in T_0. The higher total soluble solids might be due to the efficient translocation of photosynthates to the fruit by regulation of boron. The results are similar to the findings of Rawat *et al*. (6).

The treatment T_7 and T_8 have highest acidity (0.550%) followed by T_5 (0.5% zinc sulphate + 0.6% boric acid) with 0.546%. The control had minimum acidity (0.378%). Acidity percentage of guava fruit might have been augmented due to higher synthesis of nucleic acids, on account of maximum availability of plant metabolism. El-Sherif *et al.* (3) have also reported similar results.

The maximum ascorbic acid was recorded in T_7 with 221.51 mg/100 g fruit pulp followed by T_8 with 205.68 mg/100 g fruit pulp and T_5 (0.5% zinc sulphate + 0.6% boric acid) with 187.78 mg/100 g fruit pulp, respectively. The minimum ascorbic acid (123.01 mg/100 g fruit pulp) was in control. Augmentation of ascorbic acid percentage of guava fruit might have been due to higher synthesis of nucleic acid, on account of maximum availability of plant metabolism. El-Sherif *et al.* (3), Jaiprakash *et al.* (4) and Singh *et al.* (9) have also reported similar results.

The highest total sugar (8.66%) in T_7 (0.6% zinc sulphate + 0.5% boric acid) was followed by T_8 (0.6% zinc sulphate + 0.6% boric acid) with 8.29%. The minimum sugar found (5.81%) in T_0. The treatment T_5 (0.5% zinc sulphate + 0.6% boric acid) have higher reducing sugar (5.02%) was followed by T_7 (0.6% zinc sulphate + 0.5% boric acid) with 4.90%. Minimum reducing sugar was found in control with 2.99%. The maximum non-reducing sugar (3.76%) was found in T_7 was followed by T_8 with 3.47% and minimum non-reducing sugar (2.71%) was found in T_2 (0.0% zinc sulphate + 0.6% boric acid). The higher percentage of total sugar, reducing sugar and non–reducing sugar might be due to efficient translocation photosynthates to the fruits by regulation of boric acid. These results are in conformity with the findings of Singh and Brahmachari (8), Das *et al.* (2) and El-Sherif *et al*. (5). The highest sugar-acid ratio was found in T_7 (0.6% zinc sulphate + 0.5% boric acid) with 15.76 followed by T_4 (0.5% zinc sulphate + 0.5% boric acid) with 15.48. Minimum ratio was recorded in T_5 (0.5% zinc sulphate + 0.6% boric acid) with 14.41.

CONCLUSION

From the present investigation it may be concluded that the combined foliar application of zinc sulphate @ 0.6 per cent and boric acid @ 0.5 per cent before fruit set and after fruit set resulted in higher yield (46.41 kg/tree), fruit weight (162.01 g), radial diameter (7.52 cm), polar diameter (7.91 cm), specific gravity (1.024 g/cc), TSS (15.40%), acidity (0.550%), ascorbic acid (221.51 mg/100 g fruit pulp), total sugar (8.66%), non-reducing sugar (3.76%) and sugar-acid ratio (15.76).

Table 1: Effect of foliar application of Zinc and Boron on different parameters of guava.

Treatment	Fruit weight (g)	Polar diameter (cm)	Radial diameter (cm)	Yield (kg/ plant)	Specific gravity (g/cc)	TSS (%)	Acidity (%)	Ascorbic acid (mg /100g pulp)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)	Sugar-acid ratio
T_0	85.55	5.15	4.62	23.71	0.892	9.62	0.378	123.01	5.81	2.99	2.82	15.38
T_1	91.37	5.31	5.22	27.23	0.914	10.58	0.439	134.55	6.42	3.53	2.89	14.62
T_2	92.40	5.60	5.42	29.77	0.928	11.25	0.452	140.43	6.81	4.10	2.71	15.07
T_3	101.46	5.98	5.49	35.49	0.940	11.53	0.460	163.59	7.12	4.25	2.87	15.46
T_4	115.55	6.04	5.51	38.56	0.965	11.79	0.476	176.92	7.37	4.47	2.90	15.48
T_5	126.53	6.87	6.50	42.39	0.975	12.79	0.546	187.78	7.87	5.02	2.86	14.41
T_6	121.69	6.24	5.73	40.48	0.970	12.11	0.526	184.42	7.66	4.79	2.87	14.55
T_7	162.01	7.91	7.52	46.41	1.024	15.40	0.550	221.51	8.66	4.90	3.76	15.76
T_8	154.11	7.14	6.78	43.42	1.012	13.61	0.550	205.68	8.29	4.82	3.47	15.07
C.D. (P=0.05)	1.15	0.05	0.05	1.77	0.008	0.26	0.006	1.92	0.08	0.07	0.09	0.26

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Research Note :

RESPONSE OF GIBBERELLIC ACID ON GROWTH BEHAVIOUR AND MENTHOL OIL YIELD OF MENTHA (*Mentha piperita* L.)

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Keywords: *GA_3, mentha, trichome glands, menthol oil..*

Mint (*Mentha piperita* L.) is a perennial herb of family Lamiaceae which is extensively grown as domestic medicinal herb as well as for commercial menthol oil production. Essential oils are the most important raw materials for fragrance and aroma industry. They are also used widely in the food and pharmaceutical industries due to their therapeutic, antimicrobial and anti-oxidant activities. As secondary metabolites groups, essential oil compounds play an important role in the plant's fitness under environmental fluctuations (Kapoor, 4). Plant growth hormones also play an important role in the regulation of growth and development of plants by affecting sink-source relationship (Marscher, 5). Exogenous application of growth promoters (gibberellic acid) exhibits positive metabolic activities under seasonal variations (Kapoor, 4). Keeping the views in mind, the present study was aimed to investigate response of GA_3 on growth behaviour and menthol oil contents in *Mentha piperita* L. under the influences of variable seasons.

The present pot culture experiments were carried out in the Department of Botany, Dr. A.H. R.S. Degree College, Jaunpur during 2011 for two consecutive seasons i.e. winter (January-March) and summer (April-June) season (Table 1). Uniform suckers of mentha (American mint) were grown in nursery beds with whole care with appropriate supply of organic manures. Four weeks old nursery grown saplings were transplanted in suitable pots of 12 inch size. During each season (winter and summer), the pots containing soil and organic compost in 1:1 ratio were duly made for experimental purpose under suitable photoperiodic conditions. For each set of seasonal experiments, number of pot cultures of mint were maintained. All pots, replicated thrice, were treated by exogenous application (spray) of seven different successive concentrations (0, 10, 15, 25, 50 and 100 ppm) of gibberellic acid. After 75 days of GA_3 spray, in each season (winter and summer), observations on plant height, number of stolons and number of leaves per plant, leaf area, plant biomass and menthol oil contents were taken and average of three replications was analysed statistically. Leaf area was measured by Leaf Area Meter and oil content in fresh herb was estimated by steam distillation using Clevanger apparatus (Clevenger, 2).

The investigation was projectd to examine the effect of growth stimulator (GA_3) on growth behaviour and essential oil (menthol) yielding capacity of *Mentha piperita* L. under the influences of different seasons (i.e. winter and summer). A perusal of data (Table 2) revealed that plant height of mentha was linearly increased with every increase in GA_3 concentration in both the seasons and it was observed maximum (81.25 cm and 78.51 cm in winter and summer season, respectively) with 100 ppm GA_3 spray followed by 75 ppm and 50 ppm concentrations. In contrary to plant height, number of stolon branches per plant was decreased linearly with every increase in gibberellic acid concentration from 0 to 100 ppm, where the highest numbers of stolon branches in winter (111/plant) and summer (39/plant) were recorded in control (untreated) plants. This also reveals that low temperature and short photoperiod favours the laterals growth of the plant confirming the findings of Clark and Menary (1). Number of leaves per plant was also influenced significantly by exogenous application of gibberellic acid, and maximum numbers of leaves per plant (294 in winter and 475 in summer) were observed by the spray of higher concentration (75-100 ppm) of GA_3. Total leaf area per plant as well as dry biomass of plant were observed maximum with the application of lower concentration (25-50 ppm) of gibberellic acid. The higher biomass yield of mint plant of 8.87g in winter season and 10.84g in summer season was observed by the application of 25 ppm and 75 ppm GA_3, respectively. The findings are in consonance with Kapoor (4) and Garg *et al.* (3). Exogenous application of growth stimulator showed significant influences on menthol oil contents in different seasons. Spray of 75 ppm GA_3 resulted in the highest menthol oil contents of 0.85% and 1.94% in winter and summer season, respectively. As regard the seasonal variation is concerned, high temperature and long photoperiod

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Table 1: Meteorological data during the period of experimentation in two seasons i.e. winter and summer (2011).

Months	Week numbers	Date	Temperature (°C)		Relative Humidity (%)		Sunshine (hours)
			Max.	Min.	Max.	Min.	
Jan-Feb	2	08-14	21.8	8.5	91.8	35.5	6.8
	3	15-23	22.3	8.8	92.2	35.9	7.2
	4	22-28	23.6	12.6	91.4	63.2	6.5
	5	29-04	21.8	11.5	93.5	67.5	6.4
Feb-March	6	05-11	22.5	9.4	91.2	43.5	9.7
	7	12-18	25.7	12.4	91.5	54.3	9.5
	8	19-25	26.7	11.4	7.2	33.6	9.8
	9	26-05	27.8	12.3	81.9	43.1	7.6
March-April	10	05-11	24.6	12.6	85.2	51.2	7.2
	11	12-18	31.5	14.0	60.6	32.8	9.5
	12	19-25	32.7	14.5	65.0	31.9	9.7
	13	26-01	32.7	19.5	41.5	24.2	10.8
April-May	14	02-08	39.3	20.0	37.8	14.5	10.5
	15	09-15	38.9	18.2	41.5	16.9	10.8
	16	16-22	36.5	21.2	63.8	32.5	10.4
	17	23-29	40.7	22.9	45.5	23.3	10.9

Table 2: Responses of *Mentha piperita* L. for growth and menthol oil yields at 75 days after treatment as affected by GA3 and seasonal variation i.e. winter (W) and summer (S) season 2011.

GA3, Treatments	Height of plant (cm)		No. of stolon branches/plant		No. of leaves per plant		Total leaf area per plant (cm2)		Dry Biomass of plant (g)		Menthol oil yield (%)	
	W	S	W	S	W	S	W	S	W	S	W	S
0 ppm	35.50	41.16	111	39	266	345	2855.50	5574.35	7.95	10.25	0.64	1.24
10 ppm	47.55	54.40	102	36	275	348	3385.76	5384.15	8.30	10.54	0.73	1.67
15 ppm.	50.75	55.25	109	34	279	353	3491.25	5445.18	8.45	10.25	0.75	1.75
25 ppm	52.47	75.21	115	35	281	382	3592.55	6292.37	8.87	10.75	0.81	1.85
50 ppm	65.33	76.25	105	34	289	385	3485.65	6885.40	8.35	10.35	0.74	1.75
75 ppm	71.22	78.53	95	33	294	395	3383.21	5595.35	7.97	10.84	0.85	1.94
100 ppm	78.51	81.25	88	27	287	475	2798.81	4875.78	7.66	10.75	0.79	1.76
C.D. (P=0.05)	0.55	0.13	1.07	0.88	1.68	3.07	0.64	1.17	0.03	0.02	0.01	0.34

treatment (summer season) is the most suitable environment for menthol oil production as compared to winter season (low temperature, short day). It concludes that long photoperiod treatment along with higher concentration of GA_3 favours more stimulation of menthol oil contents in the peltate glandular trichomes of plant body which also confirms the findings of Garg *et al.* (3).

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Research Note :

RESPONSE OF GERBERA VARIETIES AGAINST POWDERY MILDEW DISEASE UNDER POLYHOUSE CONDITION

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Keywords: *Gerbera, disease, powdery mildew, variety, PDI.*

Gerbera (*Gerbera jamesonii* Bolus ex. Hooker F.), belongs to the family Asteraceae, is a popular flower throughout the world. Many people enjoy growing this flower in gardens or large containers (Tjia *et al.,* 12). Its demand as cut flower and also as an ornamental potted plant gaining importance in the world market and has a very good export potential because of its graceful appearance, hardiness and ability to withstand during transportation and long shelf life (Latha and Suresh, 8). The tremendous variability in gerbera with reference to flower colour, shape and size makes it more useful for cut flowers, bouquet, decoration in marriage and landscaping in gardening (Aswath and Survay, 2). Apart from domestic consumption it has got export potential also. Claims have been made that from 30-70 % of the potential lasting quality of cut flowers is determined at harvest (Halevy and Mayak, 5). In India, gerbera is mainly grown in North Eastern States, Karnataka and Maharashtra (Aswath and Rao, 1). Gerbera is susceptible to a variety of pests and diseases. Powdery mildew is one of the most destructive fungal diseases of gerbera causing significant economic losses under poly house conditions. It is caused by two fungal species viz. *Erysiphe cichoracearum* DC and *Sphaerotheca fusca* (Fr.) (Beaura *et al.,* 3). They are the obligate parasites and can affect all parts of the plants. Powdery mildew is easy to identify since to noticeable white spots or powder like appearance or white patches appear on the upper and lower surfaces of the leaves or flowers. These spots are enlarge to form a white, powder like mat, which can spread to stems and flowers also (Moyer and Peres, 9). Severely infected leaves turn pale yellow or brown and the plants eventually die. Some environmental conditions are most congenial for powdery mildew development includes high relative humidity (80-95 %), moderate temperature (20-28 °C) and low light intensities or shade. Unfortunately poly house usually provide all these condition and the varieties will react specifically. Therefore information on the varieties showing resistant reaction to powdery mildew is meagre. Therefore, in the present study, nine gerbera varieties were screened for their reaction against powdery mildew disease under poly house condition.

Screening trial was conducted at Instructional farm, Department of Floriculture, College of Horticulture and Forestry, Central Agricultural University, Pasighat, Arunachal Pradesh during April 2011 to March 2012. Nine varieties of tissue culture derived gerbera viz. Figaro, Galileo, Manizales, Marinila, Palmira, Pia, Rionegro, Tecala and Teresa were planted in the raised beds with a spacing of 30 x 30 cm under polyhouse condition. The plants were provided with all the inputs as per package and practices for gerbera cultivation. This experiment was laid out in complementary randomized design and replicated thrice with 20 plants for each replication. Powdery mildew was developed from the natural inoculums. Observations on symptoms of powdery mildew were recorded at 40 days interval upto 5 months (Approximate160 days) of planting and 10 plants per replication were selected randomly for disease assessment.

Disease severity was recorded on the upper

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Table 1: Reaction of gerbera varieties against powdery mildew during April 2011 to March 2012.

Varieties	Per cent disease index*				Disease reaction	Number of flowers m^{-2} / year	Number of sucker / plant / year
	40 DAP	80 DAP	120 DAP	160 DAP			
Figaro	0.0	3.93	6.53	9.73	R	143.00	3.80
Galileo	16.67	24.90	28.57	34.73	S	189.00	5.80
Manizales	12.50	16.90	31.33	46.93	S	137.20	3.20
Marinila	0.0	2.93	7.23	10.27	R	106.60	4.00
Palmira	0.0	1.57	6.50	9.27	R	190.00	5.40
Pia	23.77	33.27	55.00	65.30	HS	102.00	4.20
Rionegro	21.33	29.30	36.70	49.67	S	180.00	5.30
Tecala	19.33	31.00	44.93	54.27	HS	178.00	5.00
Teresa	10.33	15.67	20.77	24.57	MR	125.00	4.00

*Mean of three replications
DAP = Days after Planting

leaf surfaces at the earlier growth stages and at the later stages on the lower leaves also and rated on a 0 to 6 scale (Standard disease severity scale) as 0 = No powdery growth, 1= 1-20% of the leaf area with powdery growth, 2 = 21-40% of the leaf area with powdery growth, 3 = 41-60% of the leaf area with powdery growth, 4 = 61-80% of the leaf area with powdery growth, 5 = 81-99% of the leaf area with powdery growth and 6 = 100 % of the leaf area with powdery growth (Moyer and Peres, 9). Using the standard disease score chart, the per cent disease index (PDI) was worked out according to the FAO (4) formula and the data were analysed statistically.

$$\text{Per cent disease index (PDI)} = \frac{\text{Sum of total numerical rating}}{\text{Total number of observations} \quad \text{Maximum grade}} \quad 100$$

From the PDI calculated, the reaction of the varieties were categorized as 0% PDI = Immune to powdery mildew, 5% PDI = Highly Resistant (HR), 5-10% = Resistant (R), 11-25% = Moderately Resistant (MR), 25-50% = Susceptible (S) and 51-100% = Highly Susceptible (HS).

The results obtained (Table 1) clearly showed that all the varieties were differing to each other for disease incidence. Nine varieties of gerbera were screened against powdery mildew under polyhouse condition. Powdery mildew symptoms were first observed on the leaves of the varieties viz. Pia, Rionegro and Tecala on 30 days after planting. On Manizales, Teresa and Galileo powdery mildew incidence started only after 38 days of planting. On the other varieties Figaro, Marinila and Palmira powdery mildew incidence started only after 68 days of planting. Palmira variety showed resistance to powdery mildew with per cent disease index of 9.27% at the end of 160 days after planting followed by Figaro and Marinila with PDI of 9.73% and 10.23%, respectively. Variety Teresa showed moderately resistant reaction 24.57% against powdery mildew infection. Varieties Pia and Tecala were highly susceptible to powdery mildew throughout the experiment which showed per cent disease index of 65.30% and 54.27%, respectively. Other varieties like Galileo (34.73%), Manizales (46.93%) and Rionegro (49.67%) showed susceptible reaction to powdery mildew infection. These findings are closely supported by (Jamadar *et al.,* 6) for disease resistance in grapevine genotypes to powdery mildew infection and Sharma and Sharma (11) and in lady's finger to yellow vein mosaic virus (YVMV). To overcome economic losses due to disease and avoid repeated application of fungicide, development of resistant variety is the best method for disease management. Evaluation procedure in the green house could be used as a rapid assay to screen plants for resistance (Scholten *et al.,* 10). Screening could be important in the

development and evaluation of new resistant cultivar if incorporated into breeding programmes (Kozik, 7). Through the study, powdery mildew resistant screening methodology for gerbera under polyhouse condition has been established and few resistant varieties of gerbera against powdery mildew were indentified. Those varieties may be utilized for future breeding programme to evolve powdery mildew disease resistant gerbera varieties.

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Materials and Methods :- Heading in capitals, Full details of materials & methods used for experimentation, collection & analysis of data.

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1. Bal J.S. (1992). Identification of *ber* (*Zizyphus mauritiana* Lamk.) cultivars through vegetative and fruit characters. *Acta Hort*., **317**: 245-253.
2. Johnson D.A. (1940). *Plant Microtechnique*. McGraw- Hill Publishing Co. Ltd., New York.pp-29
3. Kapil R.N. and Arora S. (1990). Some fascinating features of orchid pollen. *J. Orchid Soc*., **4** (1): 9-28.
4. Rashid S., Ashraf M., Bibi S. and Anjum R. (2000). Antibacterial and antifungal activities of *Launaea nudicaulis* Roxb. and *Launaea resedifolia* L. *Pakistan J. Biol. Sci*., **3** (4) :630-632.

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